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THE GAS-TURBINE. SOME TESTS OF ITS PRACTICAL EFFICIENCY.

By Dr. C. E. Lucke.

The gas turbine is probably the most actively interesting problem in the field of dynamic engineering at the present time, and Dr. Lucke is one of the few workers in the subject whose investigations are pioneer—one of the fewer still who places his results freely and fully at the disposal of the profession. His article published in these pages in April, 1905, has become one of the classics of the literature of the subject, and has been recognized as basic by all later investigators. The paper now presented is yet more important and valuable, because it carries much farther and demonstrates much more concretely the fundamental proposition laid down in the preceding contribution.—THE EDITORS.

DURING the past few years the possibility of building a commercial gas turbine has interested inventors and engineers probably as much as the theoretical possibilities of this method of converting heat into work have engaged the attention of scientific men. At the present time, and as a result of these investigations, it has been shown that theoretically there is nothing whatever impossible in the problem, as is demonstrated in some two-dozen papers, most of them quite recent. In spite, however, of the conclusions that have been reached by the scientific men, that there is nothing impossible (that is to say, nothing scientifically impossible) in the conversion of heat energy into work by a gas turbine, the fact cannot be denied that there is not today any tangible result in the form of a working machine.

Inventors and engineers have experimented with a complete gas turbine, with and without steam, as well as with the various elements going to make up the system, such as the compressor, the fire, the nozzle and the turbine wheel. Some of these experimental combina-

tions have been made to run, but they cannot be considered as working machines when they merely run. To receive any consideration whatever as useful machines, they must somewhere nearly approach the steam engine or the gas engine in economy, or show promise of so doing, and must, at the same time, approach the steam or the gas engine in reliability, life, space occupied, and other commercially valuable features.

It is to be regretted that by far the most of the experimental results along these lines have been suppressed. The inventors or experimenters apparently hoped to achieve something wonderful, something which must not be disclosed to the world too soon, and so they have concealed their early work. Later, when the machine was built and operated, the failure of the machine was so humiliating that in some cases the experimenter was ashamed to publish his his results, and in still other cases it appears that large sums of money were spent for the experiments, and those who spent it did not feel inclined to give the results to the world, because they had been obtained at such large individual expense. If the results of every man who had experimented with this problem had been published, there would have been less experimenting, because it is certain that the failures of one man would have saved another. It is also extremely probable that if the results had been systematically published and given freely to all who were interested in the problem, we would today be much nearer success, or more certain of its impossibility. If a problem can be shown theoretically to be possible of solution, and when practically it is sought to carry it out in a machine the effort is without success, it may be set down as a fact that either the theory was wrong, or being right, beyond dispute, all that is necessary for its ultimate success is time, energy, and money—assuming, of course, that the result is worth while and of commercial value when attained.

Another thing to be regretted in this gas-turbine situation is the fact that instead of experimenting, many of the writers on the subject have contented themselves with mere reiteration of the well-known scientific fact of theoretical possibility. In some of the discussions on the subject the arguments have become quite bitter, all because they have been based upon one man's opinion as opposed to another, and not upon an experimental fact, which could easily be verified by anyone having the requisite apparatus. In a paper published in this Magazine about a year ago, I pointed out one of the difficulties of executing a practical gas turbine—free expansion by means of the

nozzle. That there were other difficulties everybody knew at the time, and these have been very much enlarged upon in more recent papers, but it seems to me that the most basic difficulty was the one previously made prominent. It was found by experimenting with nozzles that the temperature-drop in the nozzles between the place of no velocity and high pressure and the place of maximum velocity and low pressure was very small, and averaged about 12 per cent of what is theoretically possible, and of that which would be attained by a piston expansion of the same gases. Since that time, the temperature-drop in an actual turbine has been measured and compared with the theoretical pressure drop and the performance of the turbine operating with air has been measured. For convenience of operation the air was cold air, whereas in the practical gas turbine the air would be hot and possibly more or less mixed with steam, or possibly no air at all but carbon dioxide and nitrogen. In any event, the working fluid would be largely a perfect gas. The turbine used was a De Laval standard 30-horse-power machine intended for steam at 110-pounds pressure and having six nozzles. The turbine wheel runs at 20,000 revolutions per minute, and the power shaft 2,000 revolutions. The air used for driving the turbine was measured by a Westinghouse meter. The tests were run on no load, because the compressor used was not sufficiently large to supply the amount of air needed at full load, or even at full speed without load. With each type of nozzle three different initial pressures were used, each with a different number of nozzles. Readings were taken of the temperature of the air entering the turbine and the temperature of the air in the exhaust chamber, with the corresponding pressures. This turbine was fitted for six nozzles in all, grouped in three pairs of two each. These nozzles were all designed for 110-pounds initial pressure at three different back pressures—atmospheric, 25.5 inches vacuum and 26.3 inches vacuum. The groupings of the nozzles and the number designating their design characteristic are given in the following table.

Hole Number	Nozzle Number	Initial Pressure, Gauge	Vacuum, Inches of Mercury.
1	264	110	25.5
2	84	110	0
3	266	110	26.3
4	264	100	25.5
5	84	110	0
6	266	110	26.3

The results of the temperature-drop runs are given in the following table, which also gives the theoretical temperature-drop, assuming an adiabatic expansion of air between the same pressures.

INITIAL Press.	INITIAL Temp.	FINAL Press.	OBSERV. Temp.	FINAL Press	THEOR. Temp.	TEMPER Observ.	DROP Theor.	Per cent. of Theor. Realized	SPEED	EXPONENT Theor.	EXPONENT Observ.
85	98	.03	58	.03	−123	40	221	18.1	1,920	.290	.0380
55	93	.02	89	.02	−103	24	201	11.9	1,560	"	.0369
24	96	.01	83	.01	− 40	13	136	9.5	950	"	.0240
54	97	.10	81	.10	−102	18	201	8.9	1,880	"	.0198
40	102	.08	86	.08	− 76	17	178	9.5	1,630	"	.0232
24	109	.03	93	.03	− 30	16	139	11.5	1,200	"	.0262
35	108	.08	91	.08	− 61	17	169	10	1,695	"	.0252
23	104	.05	95	.05	− 30	9	134	6.7	1,290	"	.0156
12	101	.03	96	.03	− 1	5	100	5.	855	"	.0169
123	85	.01	60	.01	−176	25	261	9.6	1,540	"	.0206
92	91	.01	62	.01	−150	29	241	12.	1,270	"	.0258
60	91	.00	69	.00	−116	22	207	11.6	1,940	"	.0251
95	83	.01	51	.01	−157	26	240	10.8	1,750	"	.0240
76	93	.02	66	.02	−134	27	227	11.8	1 565	"	.0282
58	92	.02	68	.02	−113	24	205	11.7	1,285	"	.0289
75	81	.02	59	.02	−140	22	221	10.	1,710	"	.0226
54	89	.01	70	.01	−109	19	198	9.6	1,410	"	.0232
35	92	.01	74	.01	− 72	18	164	11.	1,075	"	.0268
68	88	.02	48	.02	−128	40	216	18.5	1,855	"	.0420
52	89	.01	59	.01	−106	30	195	15.4	1,660	"	.0374
32	87	.01	68	.01	− 69	19	156	12.2	1,220	"	.0380
42	86	.09	63	.09	− 90	23	176	13.	1,670	"	.0382
31	89	.07	78	.07	− 65	11	154	7.2	1,505	"	.0152
17	87	.03	82	.03	− 23	5	110	4.6	1,040	"	.0130
123	88	.14	68	.14	−173	20	261	7.7	1,140	"	.0160
91	93	.09	76	.09	−148	17	241	7.1	880	"	.0155
61	91	.05	80	.05	−120	11	211	5.2	530	"	.0122
103	91	.30	76	.30	−157	15	248	6.1	1,300	"	.0133
68	93	.22	81	.22	−124	12	217	5.5	910	"	.0117
48	90	.12	82	.12	− 98	8	188	4.3	520	"	.0105

Pressure in pounds gauge. Temperatures in degrees Fahrenheit.

RESULTS OF TEMPERATURE-DROP RUNS WITH DE LAVAL TURBINE, WORKING WITH COMPRESSED AIR.

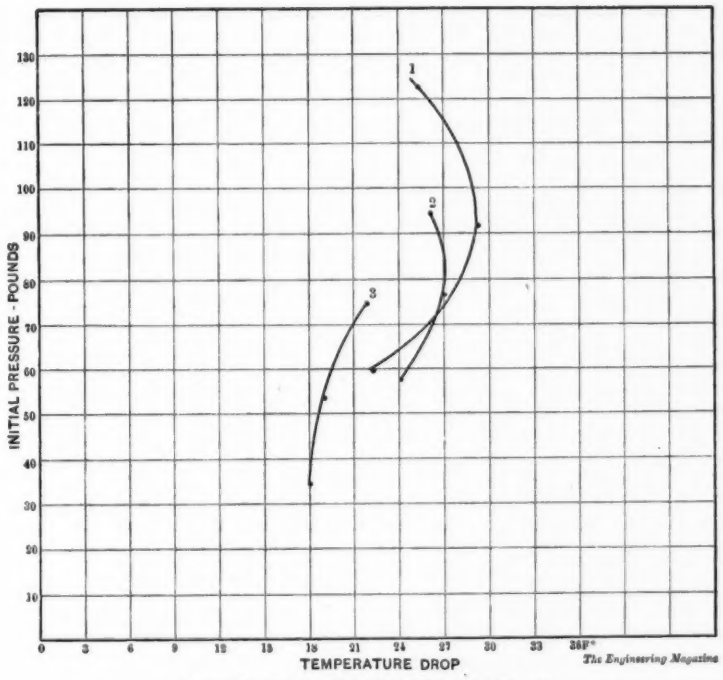


DIAGRAM NO I. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 107 nozzles; 30 horse-power. 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

From this it appears that the temperature-drop realized varies from 4 to 18 per cent of the theoretical or adiabatic temperature-drop. The preceding results are given with respect to speeds also, which varied from 520 to 1,920 revolutions per minute. To show according to what law this complete process takes place, the exponent of the temperature ratio in the equation between pressure ratio and temperature ratio, which for adiabatic expansion of air is .29, was determined and found to lie between .1005 and .0380. When plotted with respect to initial pressure the temperature-drop seems to be erratic, as shown in Figure 1 for No. 107 nozzles, Figure 2 for No. 88 nozzles, Figure 3 for No. 84 nozzles, Figure 4 for No. 266 nozzles. For each of these the proper speed can be determined from the table preceding. In general, it appears that the temperature-drop is greatest for the greatest

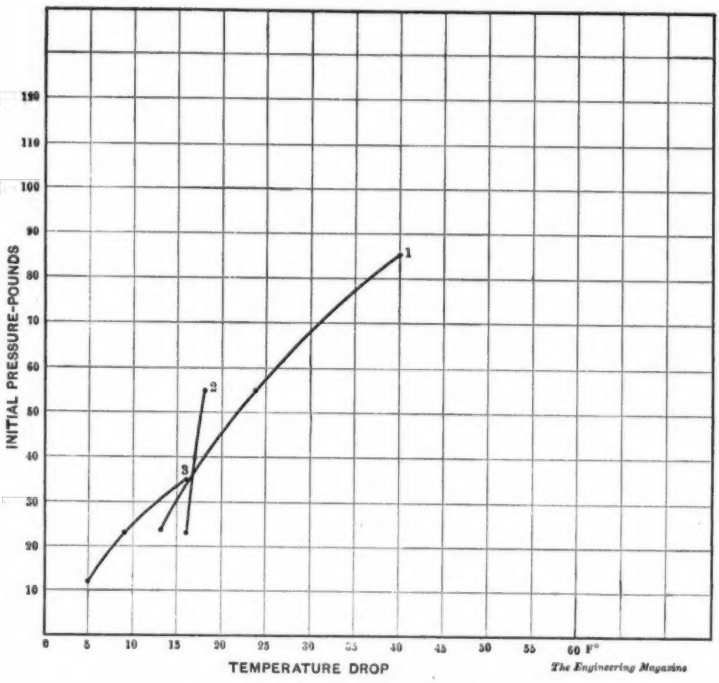


DIAGRAM NO. 2. TEMPERATURE-DROP OF AIR.

De Laval steam turbine, No. 84 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

initial pressure, but is not proportional to the nozzle pressure, and that in some cases the temperature-drop varies very little with changes in pressure, but is in all cases affected by the number of nozzles open. It also appears that speed has an influence, although a somewhat erratic one. In general, however, when the speed is greatest the temperature drop is greatest, which shows that there is a heating effect due to impact on the vanes, which is quite material and quite measurable. The nozzles differ in divergence and it appears that the results differ for different nozzles, showing that the temperature-drop is also, as might be expected, a function of the divergence of the nozzle.

Bearing somewhat on the above, but not directly, is the relation between initial pressure on the nozzles and the speed of the turbine running on no load, as was mentioned before. These relations are

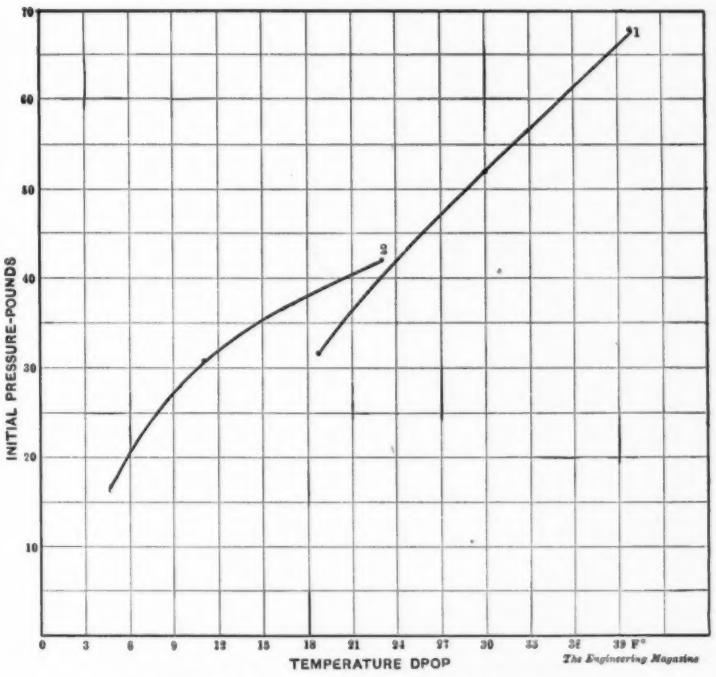


DIAGRAM NO. 3. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

given in the curves of Figures 5, 6, 7 and 8, from which it appears that speed is very nearly proportional to initial pressure but that for equal increments of initial pressure the speed increases in proportion. It also appears that the results are quite different for the different nozzles and with one nozzle and two nozzles open. The amount of air used by the turbine under these tests is plotted in curves of Figure 9 with respect to initial pressure and in Figure 10 with respect to speed. As a matter of general interest on turbines, the amount of power necessary to drive the wheel in an atmosphere of steam and air separately was measured by driving the turbine by a motor. The input energy was determined for the belt and bearing with the turbine wheel proper removed, and afterward with the turbine wheel revolving at various speeds in an atmosphere of air, then of steam. The

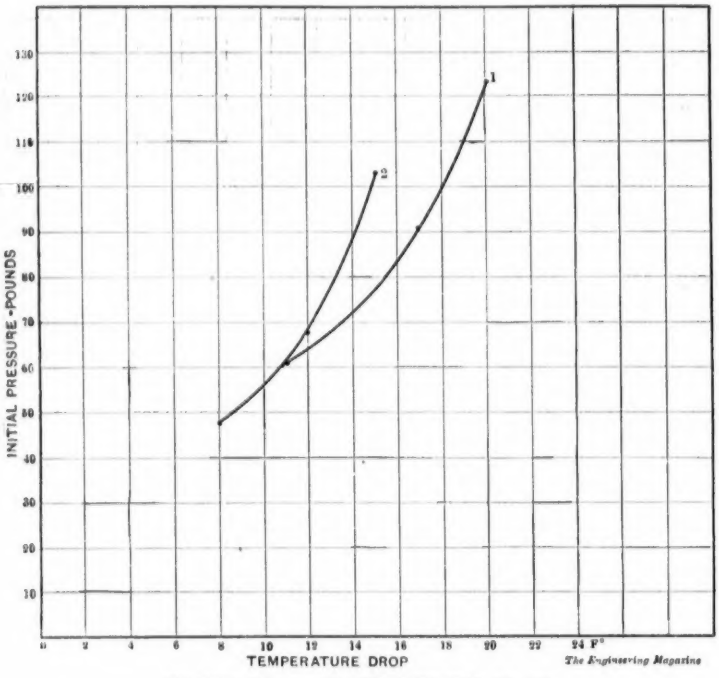


DIAGRAM NO. 4. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

difference between these readings gave the horse power necessarily consumed by the turbine vanes beating the surrounding atmosphere. The results are given in the following table:

Turbine Speed R. P. M.	H. P. Loss, Atmos. Air	Turbine Speed R. P. M.	H. P. Loss, Steam
2140	11.55	2175	10.56
1550	5.56	1560	4.53
1080	2.48	1085	1.94
955	1.89	720	.87
644	.91	493	.56

By plotting these curves and comparing the horse-power loss with air and with steam at any given speed, it would be found that above 1,000 revolutions per minute, almost exactly, the windage loss by the vanes beating in air is 1¼ times the corresponding loss with the vanes beating in saturated steam at the same pressure.

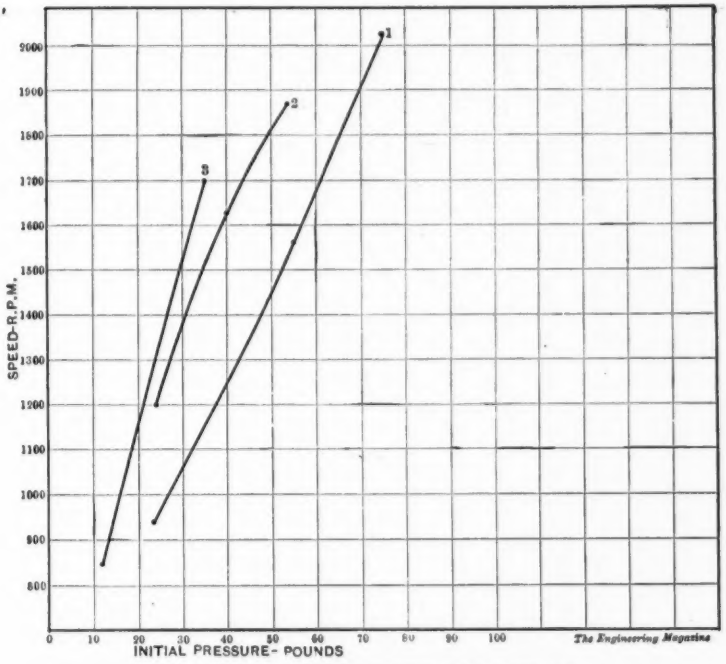


DIAGRAM NO. 5. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 88 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3 —Three nozzles open.

These experiments most emphatically confirm those previously reported, and the conclusions which were drawn from them—that the temperature drop in free expansion with such nozzles as have been used indicates very small conversion of heat into work. Stated otherwise, free expansion in such nozzles as these is very inefficient as a means for transforming heat into work.

Investigation by the author among men who have worked with compressed air and with jets and nozzles, both here and abroad, has failed in every case to develop a single case where there occurs a substantial cooling of perfect gases by free expansion. One man is probably better fitted to express an opinion than any other, by reason of his life work—Dr. Ernst Körting, inventor for many years of jet apparatus of all sorts, and of gas engines and producers. After a life

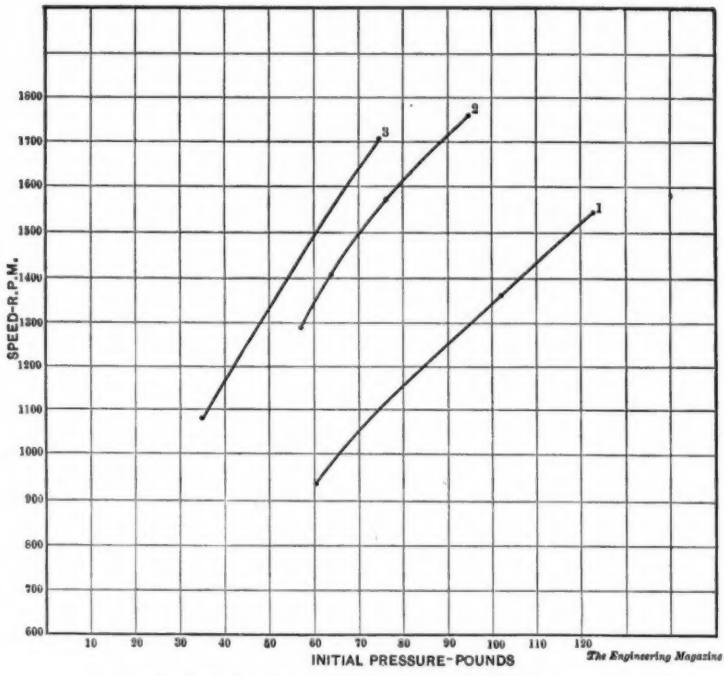


DIAGRAM NO 6. .SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 107 nozzles; 30 horse-power, 110 lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

spent in jet and gas-engine research, which has been signally successful financially and scientifically, Dr. Körting sets it down as a fact that he has never noted a single case of efficient expansion of gases, as shown by temperature-drops.

In order to secure some idea of the attitude of other engineers towards this gas-engine situation, I addressed the following series of questions to a number of men whose opinions seem to be desirable:—

A. Do you consider that there is anything theoretically impossible in the production of a gas turbine, with or without the use of steam?

B. Do you consider that there is anything practically prohibitive in carrying out the necessary process to produce a gas turbine, using either perfect gas or a mixture of perfect gas and steam?

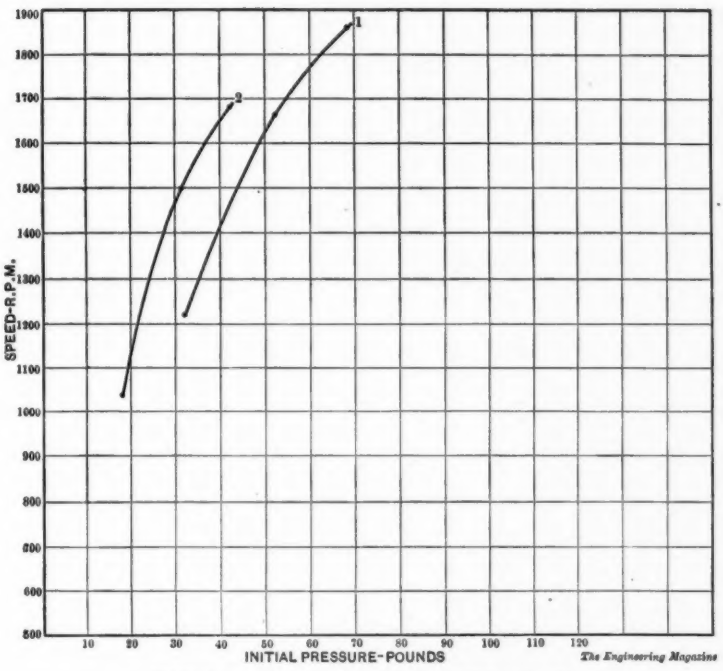


DIAGRAM NO. 7. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 84 nozzles, 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

C. What do you consider are the prospects of overcoming such difficulties as exist?

D. Do you consider that there is anything theoretically or practically difficult in the compressor part of the system?

E. In the combustion chamber of the system?

F. In the control of hot gases alone or with steam?

G. In the nozzle part of the system?

H. In the turbine-wheel part of the system?

I. In any other part of the system?

These men represent the steam-turbine field, gas-engine field, and scientific workers not identified with any particular field. Not quite half the people to whom the questions were sent replied at all, and curiously enough, most of the gas-engine engineers are in this class. Replies such as were received are given on the following pages:

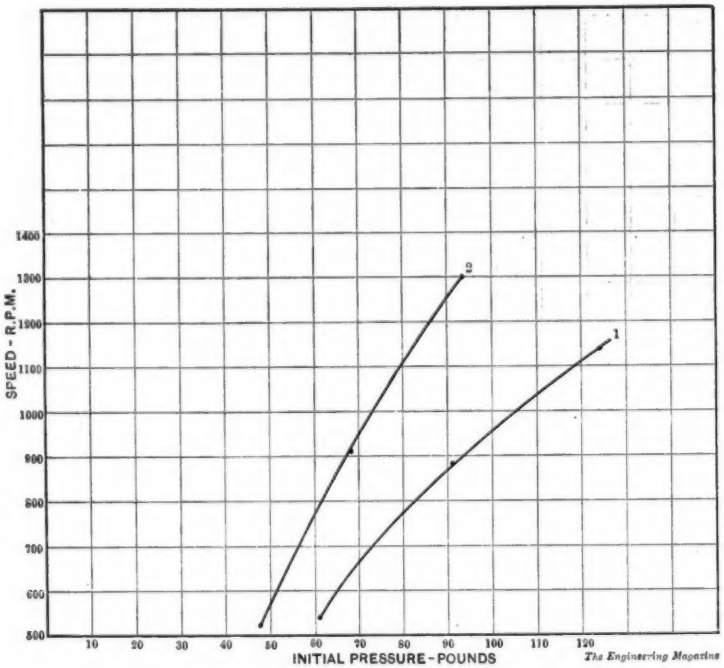


DIAGRAM NO. 8. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 266 nozzle, 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

Prof. R. C. Carpenter:

"Respecting the future commercial success of the gas turbine, I would state that I have formed an opinion which is unfavorable, due to the extremely high temperature which the working parts must be subjected to.

"Quite a number of experiments respecting the gas turbine have been carried on in our laboratory during the past eight or ten years. I felt at first that the machine could be made a practical success, but latterly I have concluded that the practical difficulties were nearly unsurmountable.

"In my opinion there is nothing in fault with the theory of a gas turbine without the use of steam, but I do not believe that there is any immediate prospect of securing metals which will stand the high temperature required for the nozzles and buckets.

"Respecting the use of a combined gas and steam turbine, I have at the present time no definite or positive information which will enable me to express an opinion as to its future practicability. I think, however, that a turbine working on such a combination might have a fighting chance of succeeding."

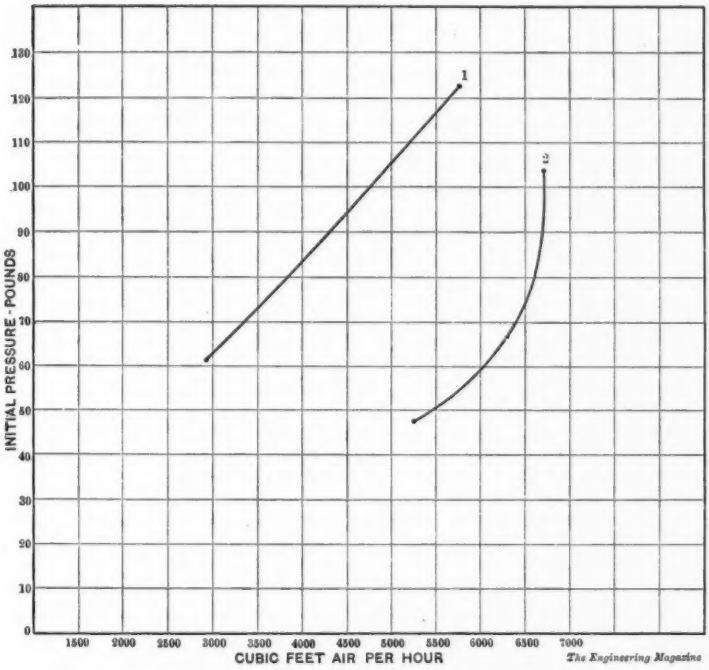


DIAGRAM NO. 9. CUBIC FEET OF AIR PER HOUR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

Prof. Sidney A. Reeve:

"A. No.
"B. At present, Yes.
"C. The prospects are excellent. The gas turbine is a new problem. The devices already standard in engineering practice were developed to meet earlier conditions. The conditions of the new problem are different. The usual period for the experimental development of a solution of the problem of building old devices along new lines is all that intervenes between the present and a practicable gas turbine.
"D. Theoretically, No. Practically, Yes. The compressor is the only unsolved and difficult part of the problem.
"E. No, either theoretically or practically.
"F. With permanent gases, yes. With steam, no.
"H. No.
"I. No.
"G. No."

Prof. Wm. T. Magruder:

"A. I see nothing theoretically impossible in gas turbines, although I am not prepared to predict how economical they will be in the use of fuel and repairs in practice.

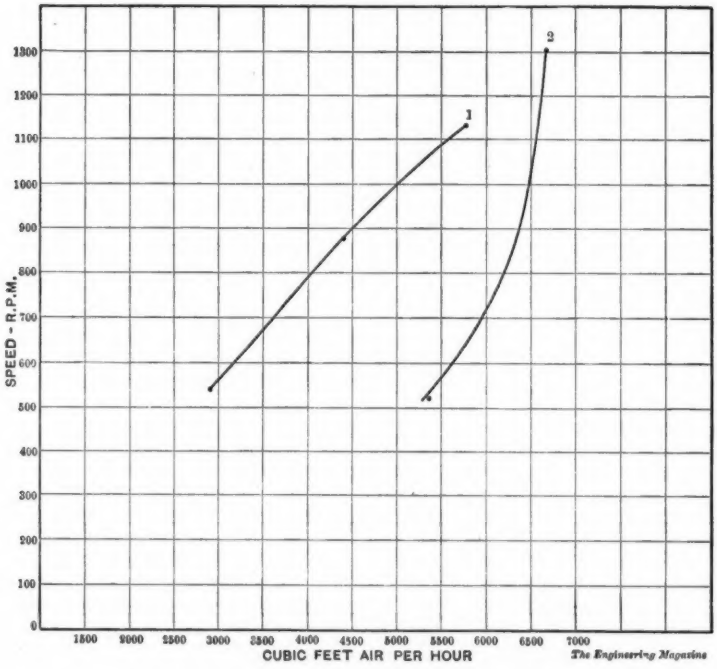


DIAGRAM NO. 10. CUBIC FEET OF AIR PER HOUR.

De Laval steam turbine: No. 266 nozzles, 30 horse-power, 110-lb. pressure, 2,000 revolutions.
1.—One nozzle open.
2.—Two nozzles open.

"B. I feel that the obtainable temperatures which are desired for maximum efficiency may cause great difficulty, unless a suitable porcelain can be obtained.

"C. I have faith enough to believe that the difficulties will be overcome.

"D. I am not prepared to say that the compression is absolutely necessary, and believe that the difficulties peculiar to the problem can be overcome. A motor-driven, 550-revolution, 3,000 pounds pressure, four-stage air compressor at 85 per cent pneumatic efficiency is the latest success in this line.

"E. Your work is an answer to this question.

"F. Without steam, it is the most serious proposition.

"G. Cannot say. Would try porcelain.

"I believe that a solution of the problem will be effected which, in its way, will be as novel as that of the steam turbine. I would, however, prefer not to make any predictions or statements at present."

Mr. J. F. Aue:

"Replying to your letter, would say that I have not paid much attention to the problem of gas turbines because I have no faith in their practical and commercial success.

"I consider myself, therefore, not competent to answer the questions."

Mr. F. E. Junge:

"A. No.
"B. No.
"C. Prospects are good if efficiency of proposed turbine is second consideration.
"D. Nothing.
"E. Yes, difficulty of cooling.
"F. Yes, thermal inefficiency when steam is generated by injecting water into combustion chamber before or during combustion.
"G. No, if properly designed.
"H. Yes, impossibility of cooling blades and finding proper material to stand high temperatures continuously.
"I. None but lack of interest in manufacturing circles and among investors."

Mr. Arthur West:

"I beg to acknowledge your letter relating to the gas turbine situation, and in reply regret to say that I have not given the subject sufficient consideration to intelligently answer your questions."

Francis Hodgkinson:

"I beg to acknowledge receipt of your letter regarding the gas-turbine situation and in reply regret to state that I can add nothing to the subject of this art. As my time has been fully occupied with steam turbines, I have not studied the subject of gas turbines."

Prof. Elihu Thomson:

"The problem of the gas turbine is certainly a very complex one, and I do not know that I am prepared to answer the questions you put, definitely, at this time. Such data as we have collected from our experimental work are naturally to be regarded as private with the General Electric Company, and, therefore, not to be used in publication. Perhaps it would be sufficient to make a general statement which covers most of the points of your questions. In the first place, I see no theoretical impossibility in the gas turbine with or without the use of steam, but I consider that the practical problems are of great difficulty, and especially the problem of compression. If we are to depend upon reciprocating compressors the question arises at once whether we had not better make them into gas engines. There certainly need be no difficulty in managing the combustion part of the process if oil or gas fuel is available. I regard the problems of construction and operation as certainly difficult, and considerable time will probably elapse before any thoroughly workable gas turbine is produced, and the problem of its competing with other machines is naturally somewhat doubtful."

W. L. R. Emmet:

"I have received your letter concerning gas turbines. About four years ago I became interested in this subject, and for a time believed that something valuable might be developed. I began to build some experimental apparatus, but gave up the work before any actual experimenting had begun. My reason for giving it up was that certain theoretical and practical considerations seem to indicate that the prospects were not attractive. My study of the subject was not very thorough, and I will not undertake therefore to express an opinion. I will, however, state briefly some of the considerations which influenced my decision.

"The useful product of a gas turbine with combustion chamber is the difference between the output and the power required for compression. Inefficiency in the process of compression or of conversion into work rapidly diminishes the useful product. The theoretical velocities are high,

and consequently the turbine element is difficult to make efficient. The cost of efficient air-compression apparatus is very great, and the result produced is not very good. I do not know what actual combined efficiency of combustion chamber and nozzle would be practicable, but I am inclined to think that a good deal of loss will be found in these parts. If high temperatures were used, combustion will probably be delayed until after expansion, which will involve large losses and practical difficulty. If low temperatures are used through the introduction of water, the process rapidly degenerates into a non-condensing superheated-steam process, which is hampered by the necessity of compressing all the air used for combustion.

"Under the most favorable conditions which can be assumed, the heat rejected in exhaust must be very large, and cannot be economically returned to the system itself, since it is expensive to compress hot air. This rejected heat could, of course, be used in a steam process, but there are obvious objections to such complicated combinations.

"Even when due allowance is made for these difficulties, theory would indicate that fair ecenomy might be obtained from a gas turbine. The development of any practicable process of this kind involves a great amount of thought and labor, and all that I can say of this process is that it seems to afford a less attractive field for development than many others to which a competent engineer might devote his energies."

After a review of the whole situation, it appears that theoretically there is nothing impossible in the problem, and such difficulties as exist are purely practical and of no mean order of magnitude. So great are the difficulties encountered by those who have experimented, and so great are those that are foreseen by practical men, whose lives are devoted to overcoming difficulties, that those who are engaged in trying to perfect such a machine as this are warned of the certainty that their efforts will be fruitless for a long time at least, that much money will be spent with no tangible results, and that the practical gas turbine is a long way off.

FIG. 1. THRESHING MACHINE DRIVEN BY A PORTABLE ELECTRIC MOTOR

THE APPLICATION OF ELECTRIC MOTORS TO AGRICULTURAL OPERATIONS.

By Franz Koester.

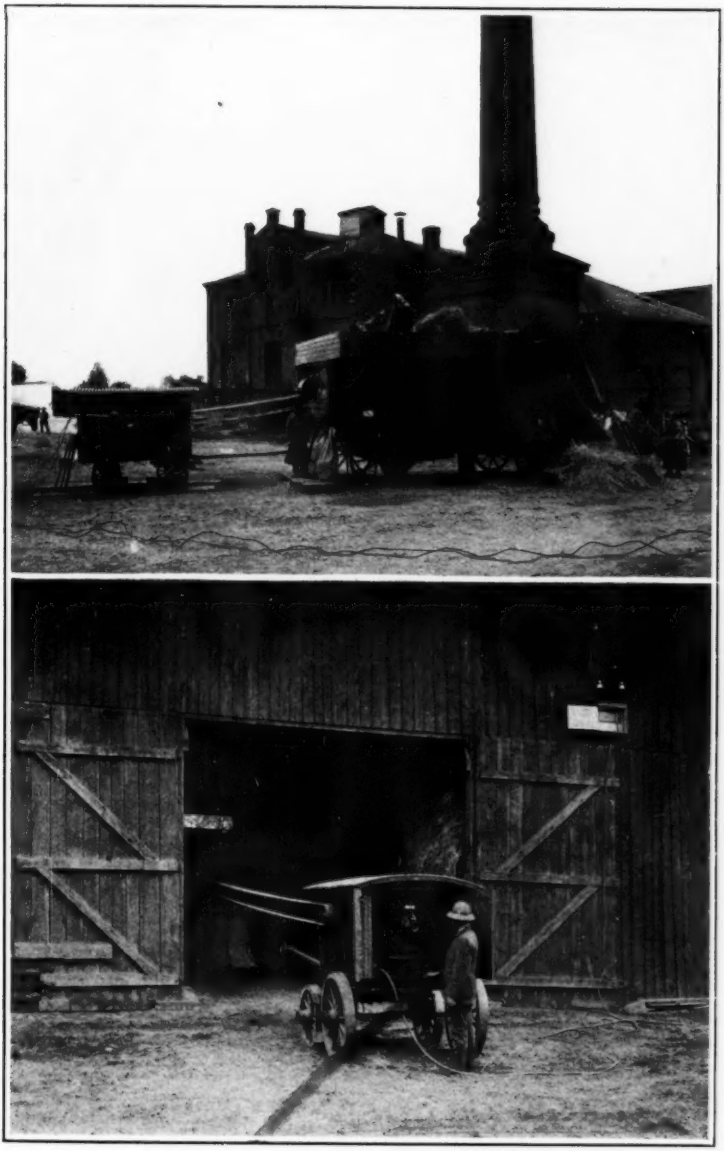
Mr. Koester's topic is of interest to THE ENGINEERING MAGAZINE, of course, by the significance it may have for the electrical engineer and manufacturer—not merely for the agriculturist. It is from this point of view that the author discusses a movement in which Continental initiative and precedent may suggest something to British and American industry.—THE EDITORS.

FOR a number of years, endeavor has been made to substitute mechanical means for the use of animal power in agriculture. The sources of power at first employed were windmills, waterwheels, etc. With this practice, the operation of farming implements and machinery was very materially complicated on account of the unavoidable introduction of long shafts, belts, pulleys, and other machinery of transmission, and in addition to this a still greater disadvantage lay in the fact that such power could be profitably utilized over a very restricted territory only, usually at the same point where the prime mover was installed. It was therefore practically impossible

FIG. 2. OVERHEAD DISTRIBUTING SYSTEM. LIGHTNING ARRESTERS ON THE NEAREST POLE.

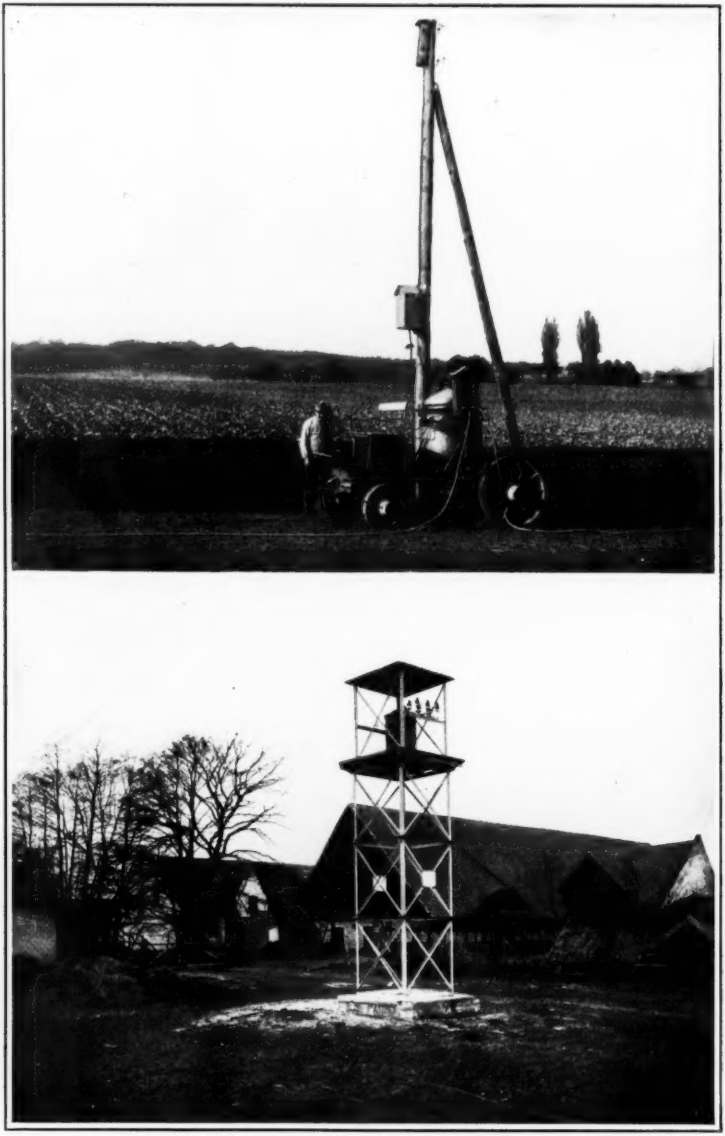
to utilize mechanical energy in the field for plowing, sowing, reaping, etc., as these require too flexible a system of distribution. On account of this latter requirement, the only mode of power easily available for this character of work is electricity. Nevertheless, before this decision had been reached portable steam engines had been used for plowing, thrashing, and other processes, but with less satisfactory economy, because water and fuel sometimes had to be supplied at great distances out in the field. Another serious disadvantage was due to the extremely heavy weight of the machinery, making it very difficult to transport it over hilly country and soft land—conditions in some cases being so severe, in fact, that it was found absolutely impossible to get the apparatus to the place of work.

On the other hand, the many advantages accruing from the use of electric power are apparent at once, as on account of the flexibility of the system, current may be easily distributed over large tracts of land, and feeders strung over the entire farm. The energy at any point may readily be converted into light, heat, or power, it being easy to transport a light electric motor over any ground. Another advantage of this system is that all the power may be drawn from a central point, as, for example, a private plant on the place; or where this is unavailable, it may be drawn at high potential from the nearest town or public-service central station and stepped down at transformer substations. If the farm is of considerable size and the consumption of energy great, or if its location is very far from any already developed outside source of supply, it will probably pay to install a private power plant. In such case a water power would be of great service, but



FIGS. 3 & 4. THRESHING BY ELECTRIC POWER.

In the lower example, the threshing machine is working directly within the barn itself, the motor being stationed outside.



FIGS. 5 & 6. STATIONARY AND PORTABLE TRANSFORMER STATIONS.
In the upper view, the attendant is shown using the field telephone

where this natural source is not obtainable, a steam, gas, or oil-engine power plant may easily be installed, the exact type depending of course upon the local conditions in regard to the cost of fuel, etc. Where the size of the farm does not justify the installation of a private plant or even the purchase of an electric motor, it might prove profitable for the central station to organize a department for the renting of semi-portable motors, to be used for the above purposes. If this is not done, one farmer might buy a motor and when not using it himself rent it to his neighbors; or where no central supply of current is available, one farmer might install a private plant and sell power to his neighbors.

Power on the farm is not used only in the field, but is also applicable for use in the buildings (residence as well as work) where it may be used for light, motive power, and heat, when a storage battery might profitably be used.

For several years the application of electricity to agriculture has been continually growing on the continent of Europe, especially in Germany, where the proprietors of large farms have been brought to see the advantages of this system. Some of the largest electrical manufacturing firms of Germany have entered actively and profitably into the development and supply of machinery in the new field, and the accompanying illustrations show views, taken on some of the busy days, on farms where electricity is used exclusively for motive power. Figure 1, for instance, represents a thrashing machine, in front of which is a portable electric motor, the power being supplied from a distance by an overhead line, a typical illustration of which is shown in Figure 2. It will be noticed that this pole line carries not only the power feeds, but also telephone wires. As these lines are run exposed to all sorts of atmospheric conditions, of course they must be supplied with some sort of lightning arrester. In this particular illustration the well-known Siemens horn lightning arresters are shown on the first pole. Another portable motor is seen in Figures 3 and 4. While in some cases the grain is thrashed directly in the field, in Figure 3 it will be seen being thrashed in the farmyard and in Figure 4 in the barn itself. This latter illustration shows clearly the method of feeding the motor and also the requisite controlling devices. These motors (depending of course upon the size and capacity of the machine) vary from 5 to 15 horse power. Where high tension is used for distribution on account of the extensiveness of the fields, or when power is drawn from a central station, transformer stations are of course necessary. These are either stationary, as illustrated in Figure 5, where the

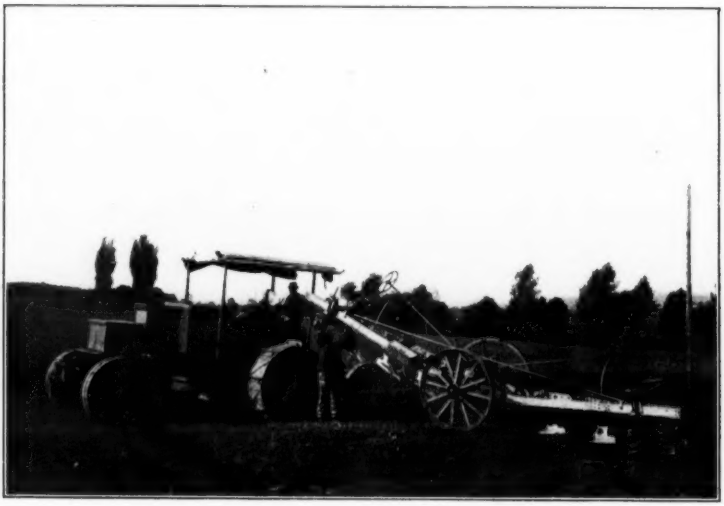


FIG. 7. A SIEMENS-SCHUCKERT REVERSIBLE PLOW, AND ONE OF THE MOTOR WAGONS OPERATING IT.

transformer is installed on a steel tower erected in the farmyard, or of the portable type shown in Figure 6, where a transformer mounted on a truck is carted from field to field as the service requires. It will be noticed that a flexible cable connects the high-tension overhead line with the transformer; thence the secondaries supply two local feeds

FIG. 8. COMPLETE EQUIPMENT OF A SIEMENS-SCHUCKERT TWIN OR TWO-MACHINE PLOW SYSTEM.

on the ground. In large fields these transformer stations are equipped with a telephone, which is clearly shown in the illustration.

Probably a somewhat more interesting illustration is shown in Figure 7, representing a reversible plow and a portable electric motor. Figure 8 shows more clearly the operation of this system, the plow being alternately drawn by similar machines at opposite ends of the field. These two motors are supplied by the two low-tension feeds shown on the ground in Figure 6. The power required by one of these twin machine plows depends of course upon the depth of the furrows, the quality of the soil, the number of shares, and the speed. The horse power usually required varies from 30 to 50. The first expense of such a plow system is comparatively high, the total cost of an equipment similar to that described being, according to the power, from 35,000 to 50,000 marks ($8,750 to $12,500); there is, however, no doubt but that if proper judgment is employed in selecting the exact size and type of machine, the money is well invested.

FIG. 9. MOTOR WAGON OF A SINGLE MACHINE-PLOW SYSTEM.

The advantage of the twin-machine system over the single-machine system is that with the latter type it is necessary to anchor one drum every time the plow is drawn across the field. This process is simplified slightly by using an anchor wagon. This anchor wagon is provided with heavy flanged wheels similar to those shown on the motor wagon illustrated in Figures 7 and 8, and a sheave over which the cable, which pulls the plow, is run. When the plow is running toward

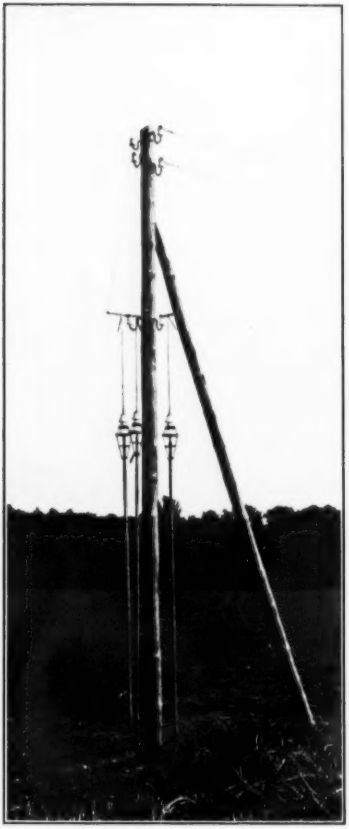


FIG. 10. CURRENT-COLLECTING DEVICE.
Note the copper strips at the base of the pole.

the anchor wagon the latter is firmly held in its position by an anchor in the ground. When the direction of the plow is reversed, the tension on the anchor wagon is released and it is a simple matter for an attendant to lift a pin, removing the anchor from the ground, and by turning a windlass to advance the wagon to the position required for the return of the plow in the proper furrow. Figure 9 represents a motor-wagon equipment for a single-machine system. Unfortunately I am not in a position to furnish an illustration of the anchor wagon.

The method of drawing current from the overhead line for the plowing system is shown in Figure 10. The lines are connected to copper strips on the side of the pole supported on porcelain insulators. From these strips, which are located some distance from the ground, the connection is made to the motor, by wires running to the ground through stiff wooden conduits, and thence to the motor through an insulated flexible conductor. This sub-feeder is easily removable from one pole to another, although this is not necessary so very often as the plow generally carries a feeding cable from 1,500 to 3,000 feet long and in some cases even longer.

Another system also used (to a smaller extent) on the Continent is that in which the driving motor is mounted directly upon a reversible plow. Current is supplied through two side trolley wires.

Electricity is used not only in the open field, but also very extensively for operating the various kinds of dairy apparatus, for shearing

FIG. 11. GENERAL ILLUMINATING (ARC-LAMP) SYSTEM FOR THE FARMYARD.

FIG. 12. A MOTOR INSTALLATION DRIVING VARIOUS UNITS OF DAIRY MACHINERY

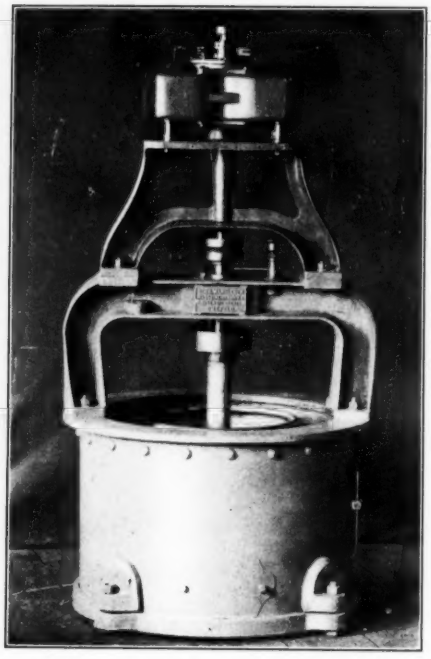


FIG. 13. AN INDIVIDUAL ELECTRIC-MOTOR DRIVE.

sheep, clipping horses, heating and ventilating, chopping food and wood, operating various pumps, sewing machines, cooking, etc.

Figure 11 gives an illustration of the general illumination of the barn yards of a prominent farm, by means of arc lamps. Frequently incandescent clusters are used for this purpose, while the various buildings are lighted almost exclusively by incandescent lamps, except when they are of very great size, where arcs are used to better advantage. Lighting is one of the most important uses to which electricity is put in the various farm buildings, as of course many places in them are very poorly lighted by natural illumination, especially in the early morning and late evening, at certain times of the year. Another important item in favor of the use of electricity for this purpose is the fact that the fire underwriters have made the premium rates lower where electricity is used than where petroleum or gas is employed, as was formerly the custom

In many cases where the size of the farm and the demand for power do not justify the installation of a large plant, a small generator direct connected to a benzine or gasoline engine of from 3 to 5 horsepower capacity is installed. This occupies a very small space, and its operation is most simple. Usually with this system a storage battery is installed, which is charged by running the generator at a convenient hour of the day, the battery discharging when required. With this equipment, practically any farm employee, with the proper instruction, may attend to the operation, while after working hours, with the battery only in operation, no attendance is required. As the potential chosen for these plants is usually 25 volts, the current is frequently

FIG. 14. SHEEP SHEARING BY ELECTRIC POWER

used for heating, cooking, ironing, operating sewing machines, etc.

Frequently where one motor is used for the operation of several pieces of dairy apparatus a line shaft is employed as shown in Figure 12, when the motor is mounted on the floor. Where this is obviously disadvantageous, direct-connected motor drive is used, an example of which is shown in Figure 13, illustrating a centrifugal cream separator.

The possibilities of utilizing electric power on the farm in sheep shearing are very forcibly illustrated in Figure 14, while many other uses, agricultural, domestic, and culinary, may be found when the current has once been introduced.

MINING AND MILLING BY ELECTRIC POWER MACHINERY.

By Charles V. Allen.

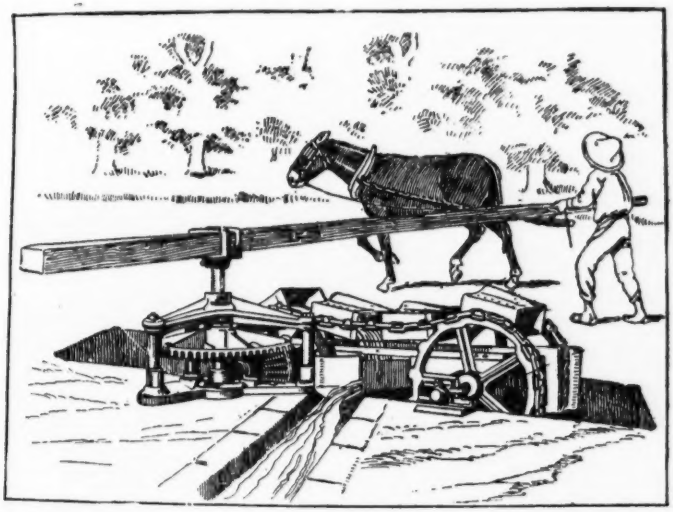
Mr. Allen's article, reviewing broadly the field of electrical applications to mining, will be followed next month by a specific example in the case of one of the largest and most modern Mexican installations—modern, that is, in so far as concerns the electrical driving of all the machinery of the mine and mill.—THE EDITORS.

By courtesy of The Denver Engineering Works.

THE OLD WAY OF HOISTING IN MEXICO

The "pigeon ladder," still used to some extent.

THE fact that the application of electricity to nearly every form of industry not only increases the output but decreases the cost of production, has long since been generally accepted and demonstrated by actual results obtained. This is none the less true as applied to the mining and milling of minerals in all countries, though the saving would of course be greater where labor is very expensive were it not for the fact that more laborers are necessary to accomplish the same operations in some localities than in others. Not only does modern machinery greatly reduce the number of employees necessary, but it also eliminates the personal equation, thereby resulting in a more uniform product and stable output. A very good example of this is found in a Mexican mine, which recently installed some electric mining locomotives, each of which with fourteen men replaced forty-five men, at the same time largely increasing the tonnage output of the mine. In one case adopting electrical haulage has enabled a mine to double its output and reduce the cost of



FORMER METHOD OF UNWATERING A MINE. DECIDEDLY LIMITED AS TO HEAD.

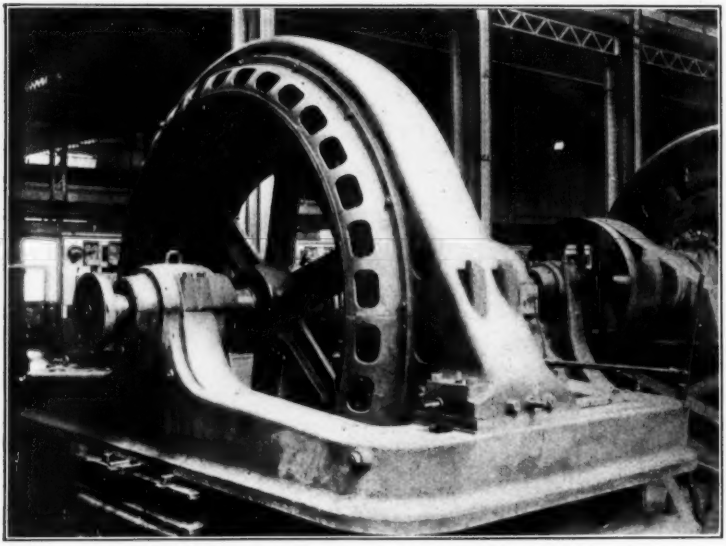
haulage from 8 cents to 1 cent per ton; this amounted to 30 per cent per annum of the sum invested in the electric power plant.

The unwatering of workings is one of the principal problems met with in mining. We know that over a hundred years ago, and up to quite recently, the natives in Mexico carried the water out on the backs of boys, and later hoisted it in a crude manner in hide bags or *mantos* with horse whims or *malacates*. We should expect economy over this method to follow the introduction of a modern high-speed electric centrifugal pump.

Before the electric pump, however, came the present steam pump which in service has proven very reliable. This, though still largely in use where electricity is not available, is now rapidly passing out of use where fuel is becoming expensive. An instance of the saving experienced in substituting electric-motor-driven pumps for steam-driven is afforded by a mine where the generating plant, motors, etc., cost $18,000, and secured a resultant annual saving of $6,000, after allowing for interest on investment and depreciation of the plant.

In the application of electricity to mining the economies do not all appear in the mere comparison of electric haulage with steam, compressed-air, or mule traction, and of electric pumps or hoists with steam or compressed-air pumps and hoists. The general flexibility

and applicability of the electric system makes possible the centralization of the power-generating plant, the improvement of the mine conditions, the decrease in the number of men required to operate boilers, engines, pumps, etc., and the reduction in cost of oil and repairs. It also renders possible the installation of hoists, pumps, blowers, etc., at points prohibitive with steam on account of distance from the boiler plant, further resulting in a saving of space, a substitution of wires for pipes on the surface and in the mine as well, and providing a safe, economical, and efficient light for mine and mill. The increase in output and the more efficient service secured in a mine and cyanide plant well lighted with incandescent and arc lamps, is conceded by all.

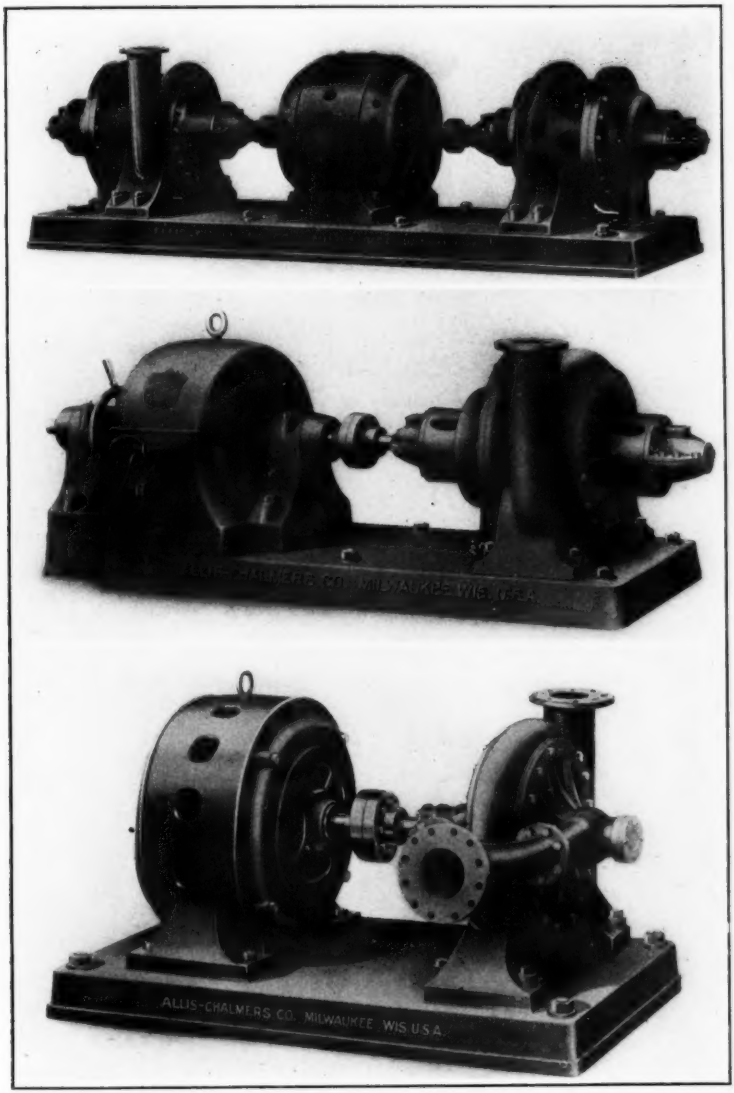


AN ELECTRIC GENERATING UNIT FOR THE MINE POWER PLANT.

A 400-kw. two-phase 6,000-volt 60-cycle revolving-field alternator. The Westinghouse Electric & Mfg. Co.

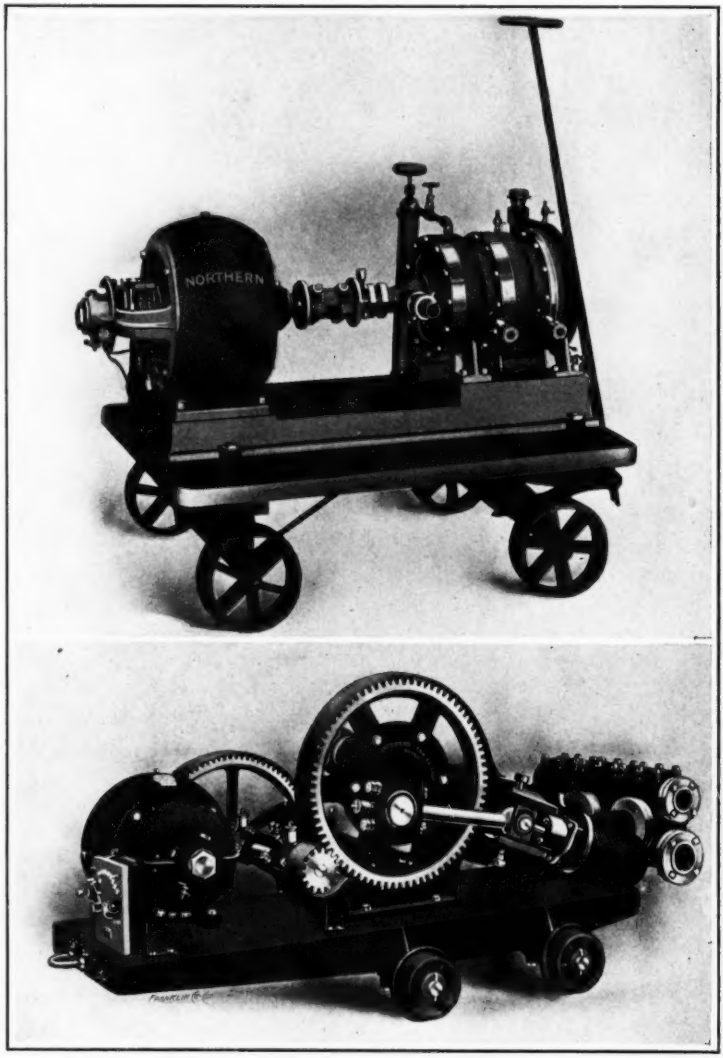
The use of electricity becomes still simpler and the responsibility less if instead of generating one's own power it can be purchased at a paying figure by the operator from some power company. This eliminates also the investment necessary for a local generating plant.

Electricity as motive power is exceptionally well adapted to the special and exacting requirements of mining and milling work. The cost of maintenance is less than in any other system of traction, the greatest saving being in cost of attendance as compared with either



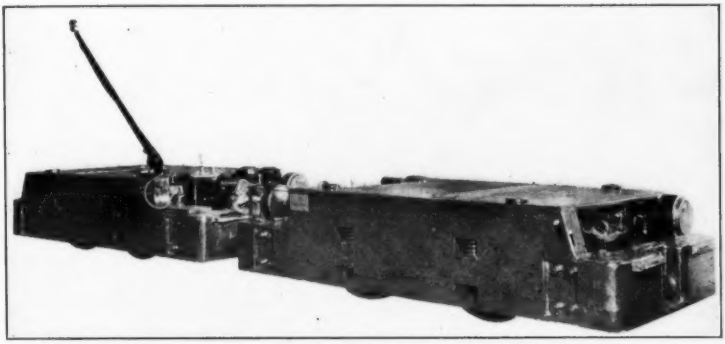
ELECTRIC-DRIVEN CENTRIFUGAL-PUMPING OUTFITS FOR MINING WORK.

Allis-Chalmers-Bullock machinery. The topmost picture shows two three-stage pumps in series, driven by induction motor; in the middle is a two-stage driven by direct-current motor; at the bottom, a single-stage driven by induction motor.



PORTABLE AIR-COMPRESSOR AND PUMPING OUTFITS WITH ELECTRIC-MOTOR DRIVE, FOR MINE USE.

The upper figure shows a three-stage centrifugal pump, built by the Byron-Jackson Machine Works, San Francisco; the lower shows an air-compressor mounted on a truck for mine service. Both are driven by Northern Spherical motors, built by the Northern Electrical Mfg. Co., Madison, Wis.



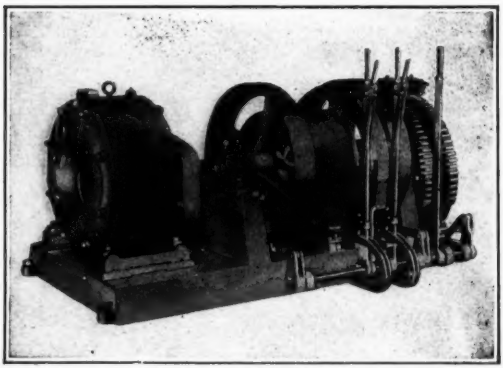
GENERAL ELECTRIC TANDEM LOCOMOTIVE FOR MINE WORK.

Weight 25 tons distributed in two machines for heavy haulage work. Suited for negotiating short curves, on account of short wheel base of each unit. Control of all motors effected from one controller. Units may also be used singly.
General Electric Co.

animal or mechanical haulage. The absence of moving parts exposed to external injury, the easy accessibility of running parts, and the simple character of the mechanism of an electric locomotive, appeals to the user.

This saving would still obtain even in cases where mines are operated as is the mine of a certain manager who, in reply to a ques-

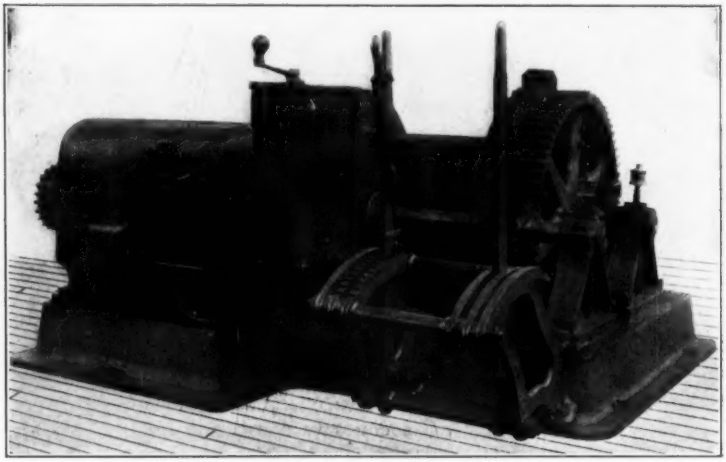
AN ELECTRIC MINING LOCOMOTIVE FOR USE IN MEXICO.
W tinghouse Electric & Mfg. Co., and Baldwin Locomotive Works.



SINGLE-DRUM MINE HOIST DRIVEN BY WESTINGHOUSE ALTERNATING-CURRENT INDUCTION MOTOR.

tion as to what kind of locomotives he used for hauling ore, remarked that his locomotives "all wore pants."

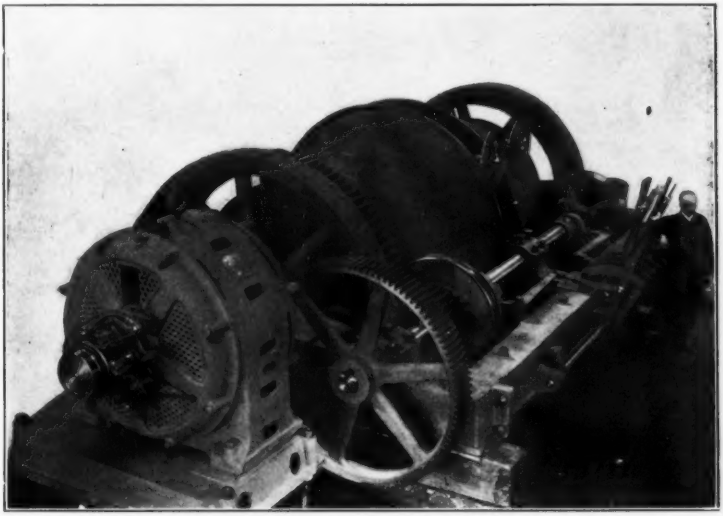
Although the steam hoist was welcomed warmly as a substitute for the hand hoist and horse whim, the electric hoist now so widely adopted is a vast improvement over previous methods. No local boiler plants, engines, long steam pipes, etc., are necessary, all this this being replaced by but three or four wires and the motor with its controller, which occupy but little room outside of the hoist proper. With an electric hoist, the controlling and varying of motor speeds is easily accomplished, the whole being readily located wherever desired, and moved from place to place as a complete unit conveniently, if not too large.



AN EXETER HOIST DRIVEN BY CROCKER-WHEELER MOTOR.

A 60-horse-power series-wound motor with reversing controller, having fourteen speeds in each direction. Capacity of hoist 20,000 lb., 70 ft. per min.

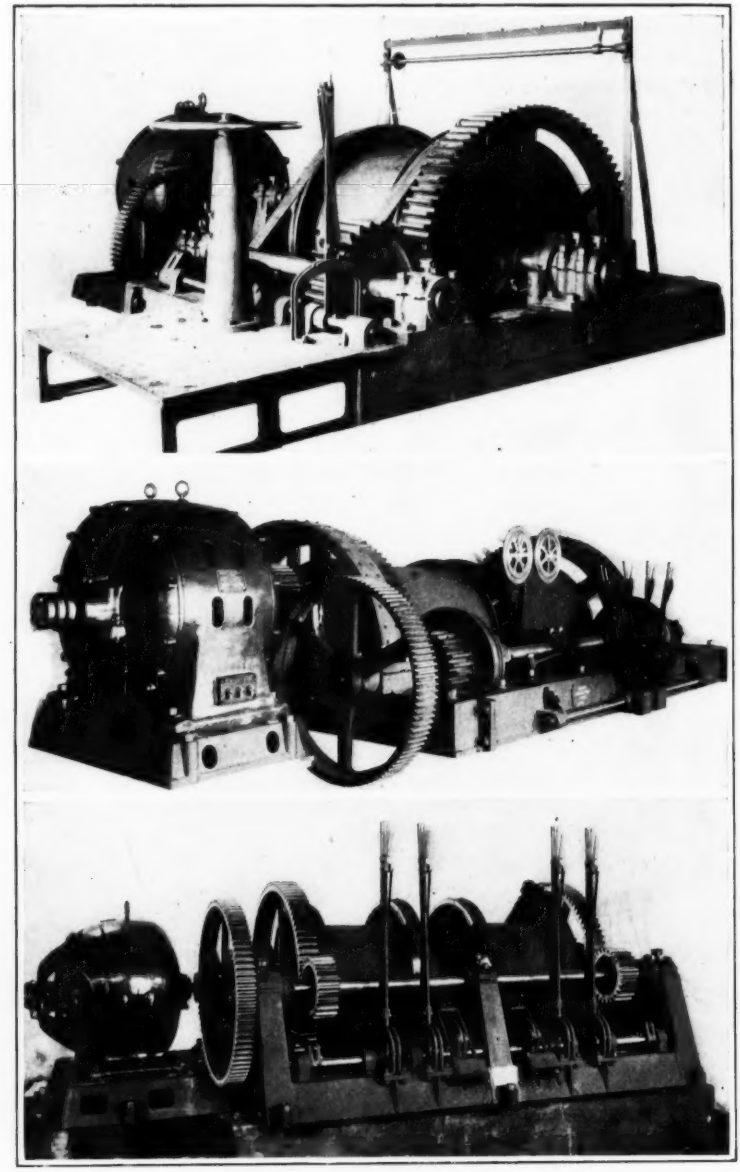
As to economy, I might cite a gold mine where steam hoisting has been superseded by electricity. The electric hoist elevated the cage at 1,250 feet per minute, raising 500 tons daily from a 2,500-feet level by double-deck cages, carrying 3,600 pounds of ore. Up to the time electricity was adopted, the cost of motive power was never less than $20.00 per horse power per month; after that time, it cost $7.00 per horse power per month.



A MODERN ELECTRIC-DRIVEN MINE HOIST.

Double-drum 150-horse power hoist built by the Denver Engineering Works for installation in the Guanajuato district. Equipped with Westinghouse motor.

Pumps and compressors require practically constant torque, or turning moment of a motor. The electric motor has been most successfully applied to plunger and centrifugal pumps at low and high speeds for all lifts and capacities. The motor is in every way economical, and has not many of the objections raised against steam pumps for mine and mill work. Although the centrifugal pump does not possess the efficiency of a plunger pump, its mechanical simplicity and low cost of maintenance win it favor in places where the conditions of service are severe, as is usually the case with mining work. One of these conditions is sinking. The service demanded of a sinking pump is extremely severe, for not only is the amount of water required to be pumped uncertain (no one knowing at what moment a large flow of water may be struck), but the head is continually increasing as the shaft grows deeper. It is necessary that the pump be

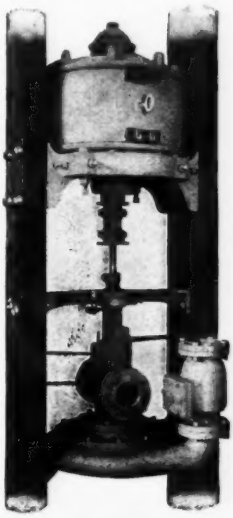


THREE EXAMPLES OF DENVER HOISTS.

The topmost is a 100-horse-power hoist, single drum with double brakes, operated by hand wheel, alternating-current motor, especially for long hauls on an incline. Below it is a 200-horse-power hoist with clutches on the intermediate shaft; General Electric alternating-current motor. At the bottom is a 15-horse-power double-drum hoist with direct-current motor. Denver Engineering Works.

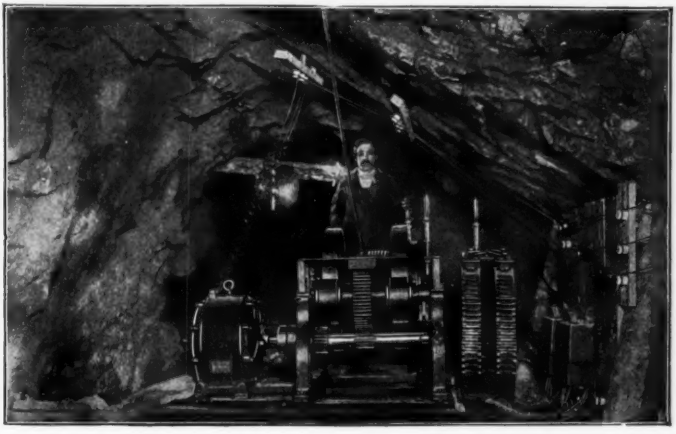
designed for some fixed head, even though the depth of shaft is constantly changing. Until this depth is reached it is necessary to throttle the discharge of the pump to prevent seriously overloading the motor. The advantages of an electric sinker over a steam pump are many, one of the principal being the substitution of wires for steam pipe. The unavoidable losses from condensation in long steam pipes in mining work with the steam pump become excessive, and the many opportunities for economy in favor of electric drive will readily be appreciated.

These electric sinkers are of late being perfected and are in much demand. With the centrifugal type of sinking pump, the motor and pump can be separated some distance, even to 100 feet or more, so that in case of a blast the motor is in a protected position, there being little exposure to injury about the pump proper. Centrifugal pumps are made to and over 100-horse power in size, operating successfully at 1,700 revolutions per minute under a head of 800 feet and more. This type of

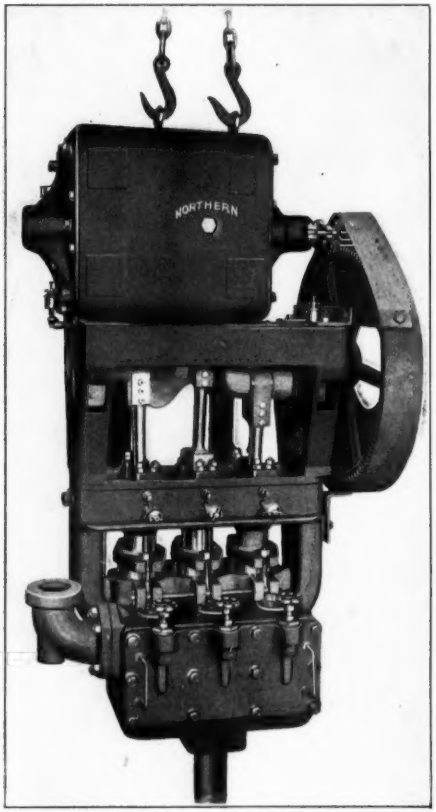


VERTICAL TYPE SINGLE-STAGE CENTRIFUGAL SINKING PUMP WITH ELECTRIC MOTOR.

Byron-Jackson Machine Works and Westinghouse Electric & Mfg. Co.



A SINGLE DRUM MINE HOIST DRIVEN BY WESTINGHOUSE INDUCTION MOTOR.



A SINKING PUMP WITH ELECTRIC MOTOR.

Northern submergible box-type motor of 5 horse power driving Allentown triplex sinking pump; 750 revolutions; the motor equipment is waterproof.

pump is also in use working entirely submerged.

It is to be regretted that the electric drill operated by an alternating-current motor has not been perfected, as its adoption would result in a great saving over the present method of carrying air pipes for long distances. Some electric drills using direct-current motors are on the market, but have not come into very general use outside of coal mining. The hard quartz in which gold is frequently found is more severe on these electric drills. In many cases the air from the drills is desirable for mine ventilation.

With steam-driven air compressors the question lies between the alternatives of locating the compressor near the boilers and piping the air, or near its place of consumption and piping the steam. With electric drive its location can always be at the most convenient point near the place of consumption. An installation of an electric motor in a California mine to take the place of steam power in driving a 100-horse-power air compressor resulted in reducing the cost of operation from an average of $1,800 per month to $672.

Fans and blowers as used in mines are required to run night and

day in unfrequented places at considerable distance from the power house, with only occasional cleaning and oiling. This is a condition ideal for electric-motor drive, particularly the modern alternating-current motor which requires as little attention as any piece of apparatus that can well be made. Inasmuch as the power required to drive fans and blowers increases very rapidly with the speed, care should be taken to select a motor of proper size to obtain the full capacity from the fan. The highest efficiency of a fan is produced at a peripheral speed of about 5,200 feet per minute and is usually adopted where noiselessness is not essential. At 4,000 feet per minute fans are noiseless when direct-driven.

A LARGE ELECTRIC-DRIVEN AIR-COMPRESSOR.

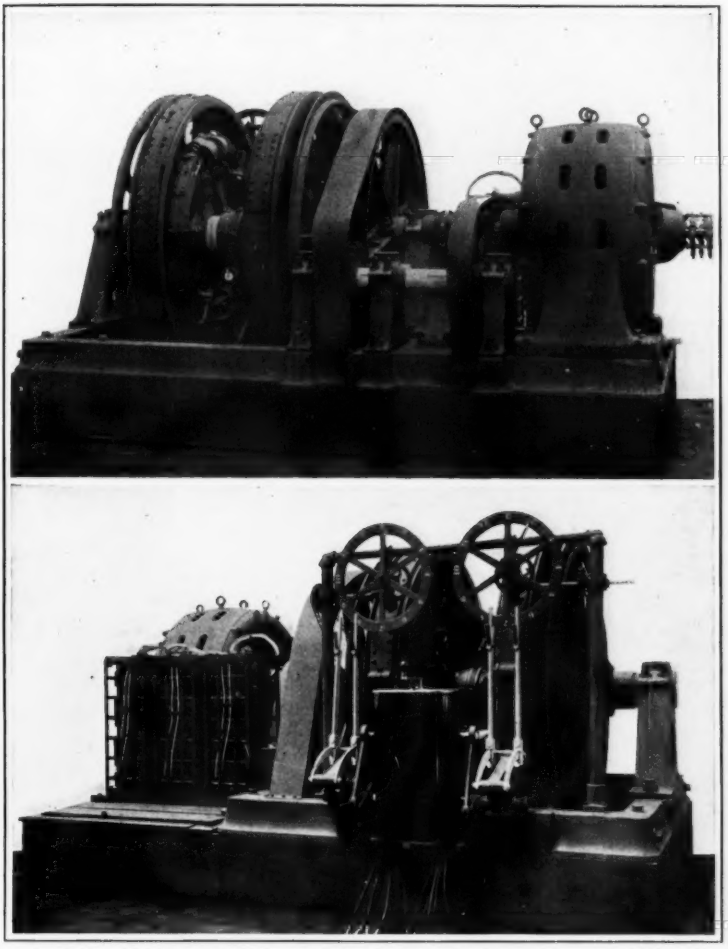
200-horse-power Westinghouse induction motor direct-connected to Ingersoll-Rand compressor.

In the adoption of electricity in a mine or mill one of the first points to be decided is the system to be introduced, whether it shall be alternating or direct-current. In the case of a very small and concentrated plant never likely to enlarge, direct current could be applied. Nevertheless few installations remain small, particularly if the anticipations of a bonanza are realized. A direct-current plant is difficult to enlarge without large expenditures for copper wire. Furthermore, commutators and wire-wound armatures should be avoided where possible.

The conditions about a mine and mill lend themselves particularly

well to alternating current as to lighting, hoisting, pumping, and driving the many constant-speed machines, such as blowers, fans, compressors, stamp-battery shafts, tube mills, cyanide-plant machinery, etc. It is true, direct current becomes necessary for the locomotives, but this is always a small percentage of the whole and can be easily obtained from an alternating-current motor-generator set. One of the advantages derived from an alternating-current system is the great convenience of readily transforming the voltage to whatever is desired, in case machines are to be driven at some distance from the power plant, and the resultant saving in the copper required to transmit the power. Undoubtedly the principal advantage is the possibility of using the squirrel-cage-type induction motor. This type of motor, properly constructed, has long been noted for the abuse it will stand. It has been compared to a grindstone in its simplicity. It will operate continuously without attention, and is provided with self-oiling bearings which require filling infrequently. It should be able to withstand excessive overloads, and be capable of being brought by an excessive

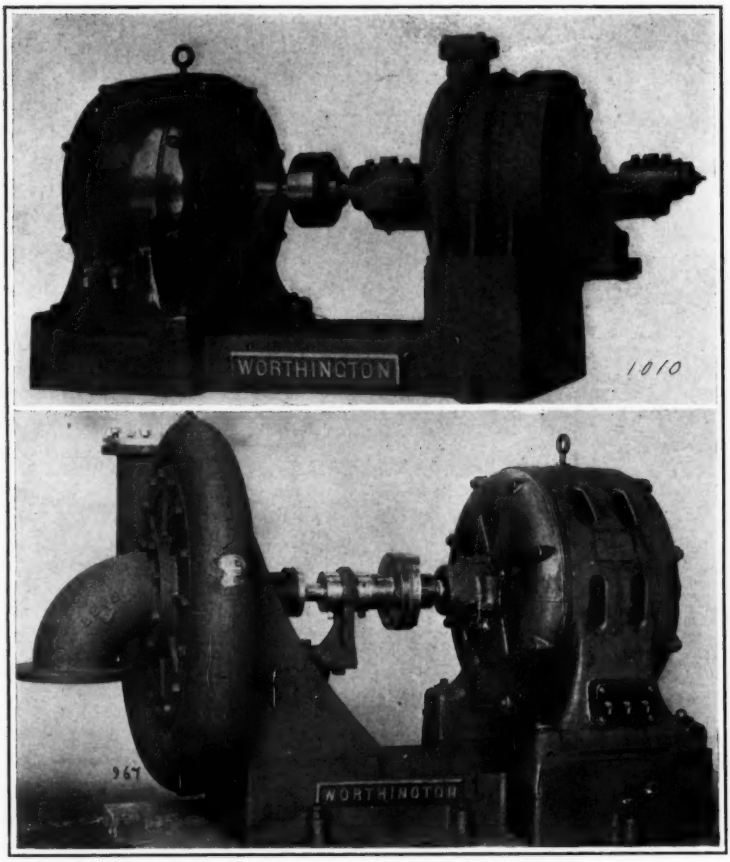
A 40-INCH REVERSIBLE STEEL-PLATE VENTILATING FAN, DRIVEN BY 10-HORSE-POWER WESTINGHOUSE INDUCTION MOTOR.



A MODERN SELF-CONTAINED DOUBLE-REEL ELECTRIC HOIST. FRONT AND REAR VIEWS.

Built by the Wellman-Seaver-Morgan Co. and equipped by the General Electric Co. for the Velardena Mining & Smelting Co., Velardena, Durango, Mexico. Hoists a load of 7,700 lb., of which 4,000 lb. is ore, from a depth of 1,000 ft. at an average speed of 550 ft. per min.; reels, 3 ft. and 8 ft. diam. Motor, 150-horse-power 550-volts. General Electric induction type.

overload to a full stop for a short time without injury. It has no brushes, commutator, slip rings, nor other moving wires or contacts, and is therefore entirely sparkless, so that no danger can result from fire. The motors are bar wound, instead of wire wound, which gives

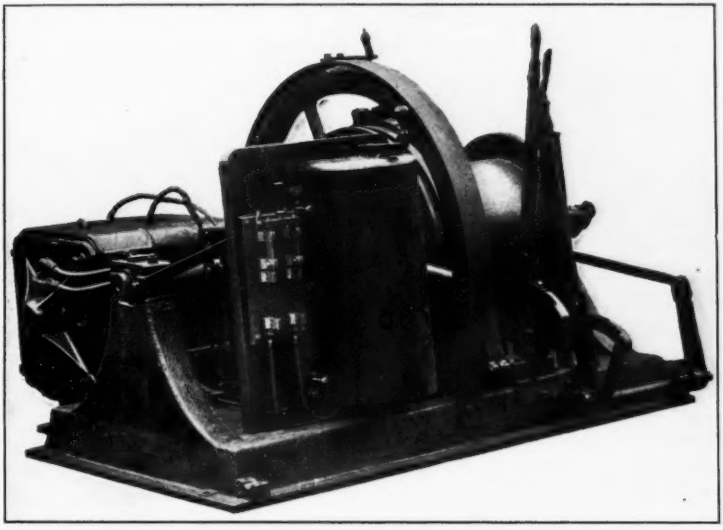


ELECTRIC-DRIVEN CENTRIFUGAL PUMPING INSTALLATIONS FOR MINING USE.

Electrical equipment by the General Electric Co.; hydraulic machinery by Henry R. Worthington, Inc. The upper unit is driven by a 50-horse-power direct-current motor, the lower by a 35-horse-power 440-volt induction motor.

an absolutely indestructible construction. They will withstand exposure to a reasonable amount of dust, dirt and moisture, and do not require skilled labor to start and stop them. The multipoint, oil-immersed auto-starters employed in starting them reduce the main-line current at starting to a minimum, which relieves the system and consumer's meter greatly, as well as the motor.

The extent to which electricity has been adopted corresponds very closely to the extent to which its possibilities and the profits following its introduction have become generally known. A parallel instance is the introduction of electric-power distribution in factories. This progressed very slowly until a sufficient number of factories had been equipped to make the superior merits of electric power everywhere



NORTHERN BOX-TYPE ELECTRIC MOTOR DRIVING GALENA HOIST.
Northern Electric Mfg. Co., Madison, Wis., and Galena Iron Works Co., Galena, Ill.

manifest. No one now hesitates to equip a new factory with electric apparatus, and in hundreds of old factories the existing equipment of belts, shafts, pulleys, and other devices are being ruthlessly scrapped to make room for electric motors. The advantages of electric power over other means of transmission are even more decided in the field of mining than in manufacturing plants, and a rapid increase in the use of electrical machinery is taking place in all branches of the mining industry.

Among the many motors which comprise the equipment of an electrically operated mine and stamp mill practically all are constant-speed, except those operating hoists. If these latter are large in capacity in proportion to the total motor load or that of the local generating plant, they will be apt to prove the disturbing feature of the system, on account of the heavy currents drawn from the line at

the time of starting and accelerating the load, which occurs very frequently. The effect on the line can be modified by many resistance notches on the controller, but as the operator always desires to make the greatest number of trips possible per hour and to accelerate quickly, he does not tarry long on the first few controller notches. This is not so injurious to a system and does not disturb the other motors and lights as much in a plant with ample generating capacity located near at hand; it is, however, a very serious objection where the electric power is transmitted many miles from a distant source. The current in a line feeding many induction motors is always lagging, the effect of which on the regulation of the generator is to demagnetize its field and thus reduce its terminal voltage. These surges thrown on the circuit of a transmission line by large induction hoist motors magnify the effect, producing poor regulation over the entire system. This might become so severe as to throw the synchronous motors, if any on the circuit, out of step. Two or three methods of overcoming this troublesome feature have been proposed; one which has proven very successful abroad in connection with hoisting work has recently been introduced into America for the first time, and will be described in a following article as applied to some hoists in the El Oro district of Mexico.

The usual form of alternating-current induction motor, which is most simple and in general use everywhere on American hoists, has a coil-wound secondary and a very high starting torque. At starting an external resistance is connected in series with the secondary winding. This is cut out, step by step, until the secondary winding is short circuited, when the motor runs at a practically constant speed and with very good efficiency. The drum type controller for this type of motor consists of a main drum with contacts arranged so as to cut the resistance in and out, and a second drum by which the motor connections may be reversed and the primary of the motor thrown on and off the supply circuit, both drums being operated by a single handle on the top of the controller.

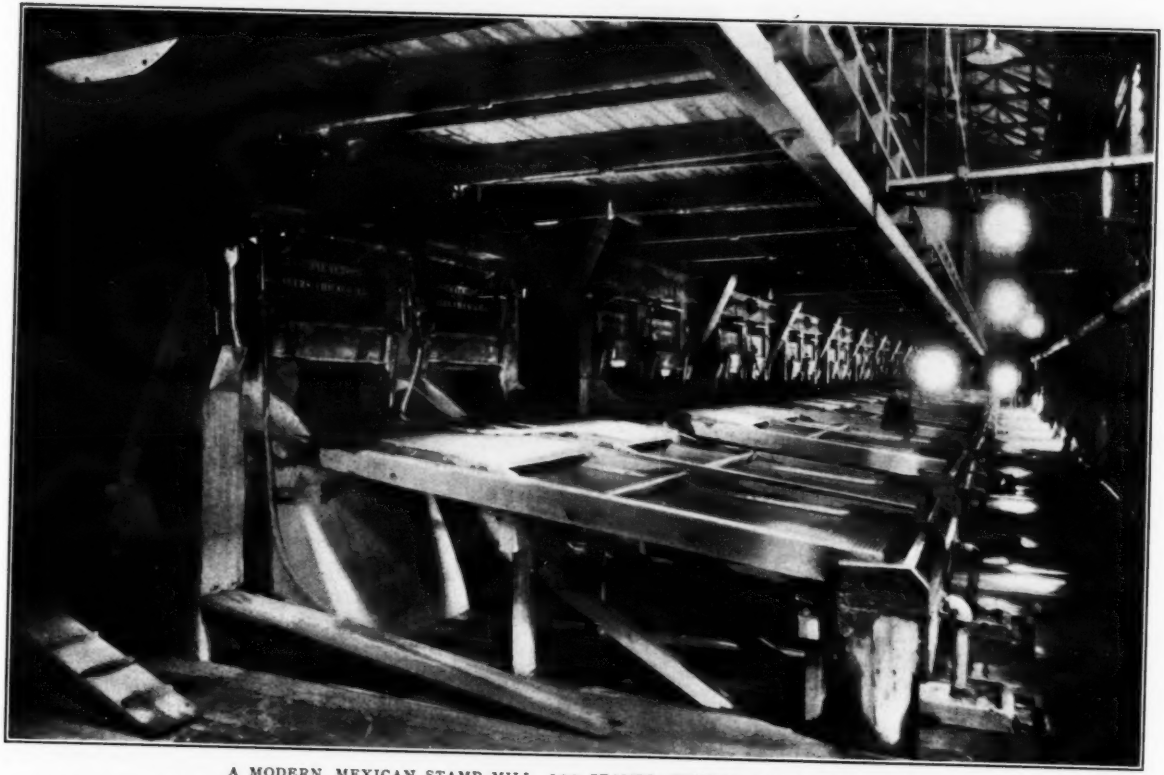
To counteract the lagging current or low power-factor effect on the generating system, some power companies selling power to mines or mills located at long distance from the source require that all motors above a certain size, especially those of variable speed, shall be of the synchronous type. These can be designed to give a leading current or power factor of say 80 per cent by variation of field strength, which if comprising about one-half the total load (which is rarely the case) would give a resultant power factor close to the ideal

FOUR SELF-CONTAINED DOUBLE-REEL ELECTRIC HOISTS.

Built for the Velardena Mining Co. by the Wellman-Seaver-Morgan Co. and the General Electric Co. Hoist from a depth of 1,000 ft. at an average speed of 550 ft. per min.; load 5,100 lb. total, 2,000 lb. ore; drums 54-in. diam., 36-in. face; induction motors of 100 horse power, 550 volts.

100 per cent so much sought by all power-plant operators. The usual machines eligible to synchronous-motor drive in such service as we are considering, in mine and mill, would be the compressor, large motor-generator sets where much direct current is wanted for locomotives, main motors driving stamp-battery shafts, etc. Any of the motor-driven machines could be so driven say where the motors are above 100 or 200-horse power in size.

In order that the synchronizing power of such synchronous motors may not be sacrificed by making them self-starting, they should be started by small auxiliary motors, similar to the induction type of hoist motor referred to above in conjunction with a controller and resistance having several steps. Considerable care should be taken in the specification of a synchronous motor to be placed on the end of a long-distance transmission line. A motor of this type operating on a circuit with varying disturbances tends to follow these disturbances, or "hunt" as it is called, and in the extreme may even drop out of synchronism and stop. The only remedy for this is an application to the motor of what corresponds to a governor—or a flywheel—on an engine. In the case of the motor, "dampers" are the governor. These consist of heavy copper castings in the form of grids entirely surrounding and also cutting the surface of the poles of the motor. They are like a transformer secondary, there being developed in them local currents, induced by line fluctuations, which currents in turn react to reduce the fluctuations. The steadying effect of a large motor of this

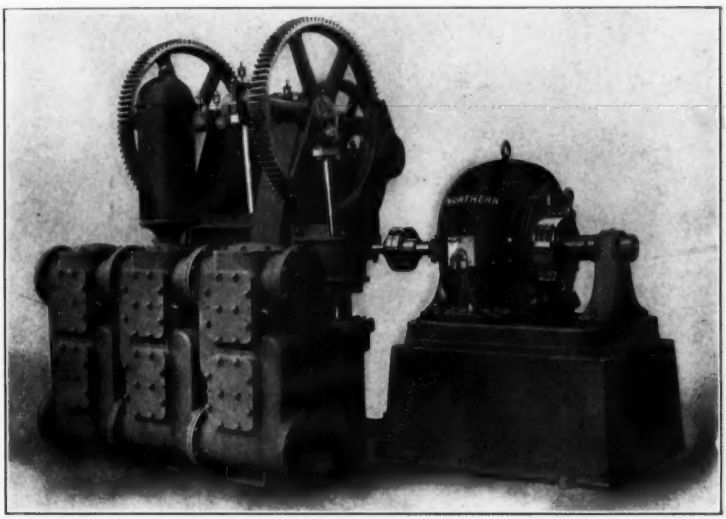


A MODERN MEXICAN STAMP MILL, 100 STAMPS, DRIVEN BY ELECTRIC POWER.

Originally installed by the Allis-Chalmers Co. as a steam mill, and electrically equipped by the Westinghouse Electric & Mfg. Co., El Oro, Mexico.

type properly fitted with these heavy dampers is very marked and beneficial to the system.

These precautions with the motor do not give their best results, and may all be for naught, if similar steps are not taken with the generators by providing them also with dampers to correct for speed fluctuations and tendency to field distortion resulting from line and load disturbances.

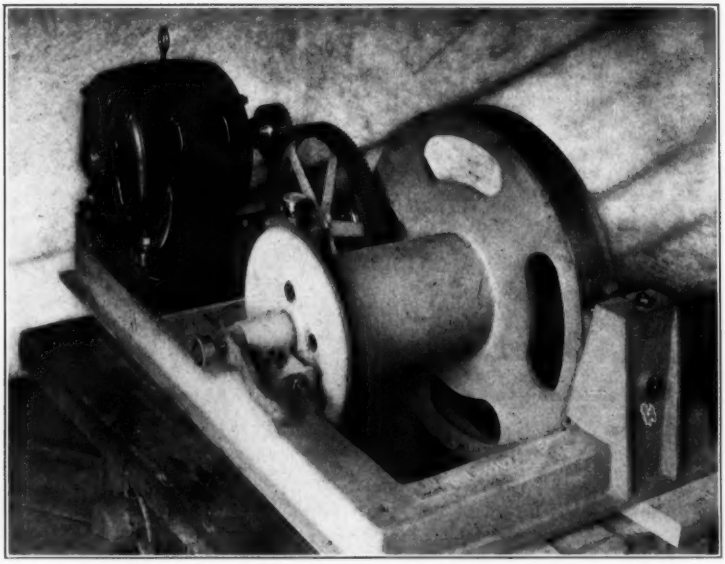


ELECTRIC PUMPING MACHINERY FOR A MODERN MINE.

Northern ring type motor of 50 horse power driving Goulds triplex pump, 11 by 12. A change gear in the back of the pump affords speed variation.

Naturally a synchronous motor requires more attention in starting, is more sensitive to abnormal or emergency conditions on the circuit, and is more expensive than a straight induction motor. If built to give a large leading power factor, a larger machine is also necessary. The popular general use of the induction motor has arisen largely from its simplicity of operation, together with the extreme amount of abuse it will stand in any kind of service—more than any other kind of motor made. It is evident synchronous motors should only be adopted for the larger sizes, and that the generaors should have good inherent regulation, especially if the motors on the system are large in proportion to their size, and the load fluctuating.

In the equipping of stamp mills the more usual practice is to drive the main shaft in sections, which in turn drive the cam shafts so as to



AN ELECTRIC WINZE HOIST.

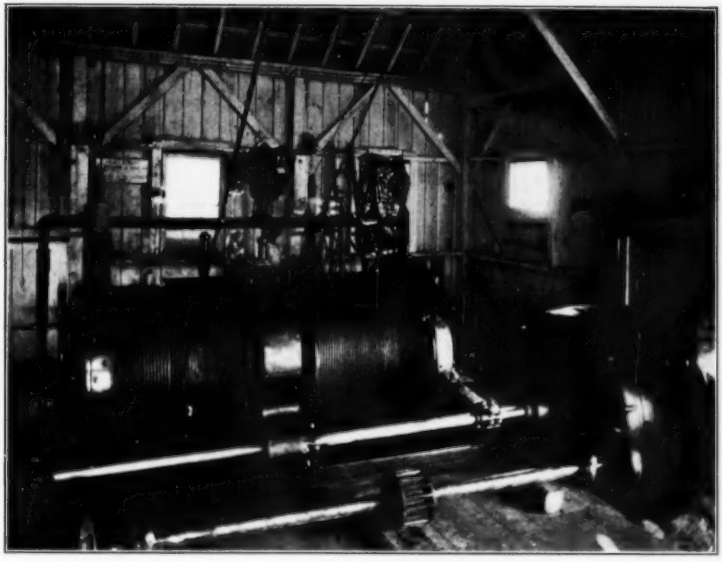
Made in 1 to 3-horse-power sizes. Designed especially for the Compania Minera de Penoles de Mapimi, Durango, Mexico, by the Denver Engineering Works. About forty of these hoists have been installed.

give from 100 to 104 drops per minute to the stamps, there being two drops of the stamp to each revolution of the cam shaft. There are probably more mills equipped with 50-horse-power motors driving units of 20 stamps each, though a few are operating with 100-horse-power motors on 40 stamps and some with 350-horse-power synchronous motors driving an entire mill of 100 or 120 stamps. In almost all such installations as the last referred to the mills were formerly driven by steam, and the steam connections are left as much intact as possible, if for any reason it should prove desirable or necessary to drive by steam for a short time. This of course means considerable friction loss in long line shafts, and means the shut down of the entire mill in case of trouble with motor or transmission. There is little doubt but that such drives will in time be changed to unit drives as confidence is established in continuous electrical service, which is comparatively new for this work; then the steam engine and boiler plant will be divorced entirely.

The ore-crushing plant about a mill is a simple application of an induction motor of proper speed and horse power, depending on the size and type of crusher used. One or more can be belted to the

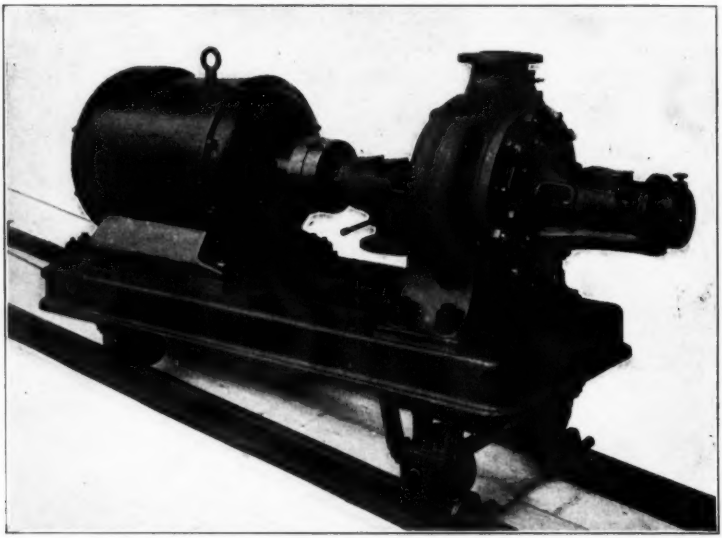
motor, or to jack shafts driven by the motor. With this type of motor two pulleys can be placed on the motor shaft, extended on both sides to drive two crushers, if desired. The flywheel of the crusher, together with the flywheel capacity of the motor rotor, is ample, with the proper capacity motor, to withstand the heaviest shocks due to large or hard ore.

Small electric locomotives, motor-driven belt conveyors, or ore cars pushed by hand, are employed in distributing the ore from the crushers to the various ore bins above the stamps. The sands from the stamps after passing over the amalgamating plates, next enter the tube mills for still further grinding. As to whether or not this second pulverizing or grinding is profitable is determined by the class of ore being handled, the object being to divide the sand so finely that the cyanide, in the treatment later, can get at and combine with the greatest possible amount of the gold. The economical point of regrinding is reached when the difference between values obtained and the total cost of regrinding is only a few cents. These mills are cylindrical shape, varying in diameter and length according to



A DOUBLE-DRUM SINGLE-REDUCTION ELECTRIC HOIST CHANGED OVER FROM STEAM DRIVE.

The old steam-driven pinion shaft is seen in the foreground. The new electric equipment is by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.



TWO STAGE ELECTRIC-DRIVEN CENTRIFUGAL PUMP FOR USE IN A MINE DRIFT.
1,440 revolutions, 46 brake-horse-power; Gebrüder Sulzer, Winterthur, Switzerland.

capacity. They are of heavy iron construction with steel or stone linings.

When designing a plant and laying out the motors for it, great care should be taken to select motors which are adequate to meet the starting conditions that will be encountered.

In a cyanide plant, the ideal condition is the application of individual motors to each machine, or small group of machines, as in the case of the mechanical agitators. By this method any one machine may be stopped when no work is to be done, or when repairs are necessary.

THE WORKING MAGNESITE DEPOSITS OF CALIFORNIA.

By Frank L. Hess.

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MAGNESITE, while not a common mineral, is found at a considerable number of places in different parts of the world associated with large areas of serpentine, peridotites, and pyroxenites. The principal foreign deposits now worked are in Germany, Austria, Greece, Italy[a], Norway, and India[b]. Unworked deposits are known in Lapland, Sweden, Russia, Africa, Australia, Quebec[c], British Columbia, and Mexico; of these the deposits in Quebec may be altered sedimentary rocks.

In the United States the most important occurrences are in California, with lesser ones in southern Oregon, Nevada, Pennsylvania[d], Maryland[e], and Massachusetts.

The Pennsylvania and Maryland deposits were at one time worked in a small way and the product used for making Epsom salts and other chemicals, but magnesite from Austria and Greece can now be imported so cheaply that they no longer pay to operate.

In California there are many deposits scattered along the Coast Range from the Oregon line to below Los Angeles, with a few along the foot-hills of the Sierras. Deposits are worked near Livermore and Porterville, and mines were formerly operated at Chiles Valley, Pope Valley, and, in a desultory way, at other points. The four places mentioned were visited by the writer in November, 1905.

Composition and Uses.

Magnesite, as it occurs in the California deposits, is a beautiful white, fine-grained rock, with a conchoidal fracture that looks like

[a] D'Achiardi, Giovanni, La formazione della magnesite all' Isola d'Elba. In *Atti della Società Toscana di Scienze Naturali, residente in Pisa, Memorie.* Vol. XX., 1904, pp. 86-134, 3 plates.

[b] Eckel, Edwin C. Cements, Limes, and Plasters, their materials, manufacture, and properties. New York, John Wiley & Sons, 1905, p. 150.

[c] Hoffman, G. C. Rep. of the Section of Chemistry & Mineralogy, Ann. Rep., Canadian Geol. Surv., Ottawa, Vol. 13, 1905, pp. 14-19.

[d] Frazier, P., Jr., *Lancaster Co., Second Geol. Surv.* Pennsylvania, Vol. CCC., 1880, pp., 86, 97, 176-196.

[e] Bascom, F. The Geology of the Crystalline rocks of Cecil Co. In *Cecil Co., report, Maryland Geological Surv.*, 1902, pp., 96-97.

a break in fine china. It is magnesium carbonate, $MgCO_3$, and is about one-third harder and heavier than calcite. It contains 52.4 per cent of carbon dioxide (CO_2) and 47.6 per cent of magnesia (MgO). Like limestone, it gives off carbon dioxide upon burning, and it is used for producing this gas, as the proportion contained is much greater than in limestone, which carries but 44 per cent. The residual magnesia left upon burning is also more valuable than the lime left upon burning limestone, and the amount of heat required to drive off the CO_2 is less. The burned magnesia (MgO) is used for making refractory brick for use with basic slags, as in copper smelting and some steel making, as an adulterant in paint, and medicinally. After being changed to the sulphite it is used in the digestion of wood-pulp for paper. The light carbonate, known also as *magnesia alba levis,* is employed for medical and toilet purposes, and with varying amounts of asbestos (15 to 50 per cent of the whole) for pipe coverings and boiler lagging. As the sulphate it is known as Epsom salts, large amounts of which are consumed in warp-sizing or weighting in cotton mills, and smaller amounts in medicine. The chloride is used as a cement and the hydrate in sugar making.

The low price of magnesite (about $6 per ton landed at New York City) makes its mining on the Pacific Coast possible only for the local demands unless manufactured into more valuable forms. The Rose Brick Company, a subsidiary company of the American Magnesite Company, has recently established a factory at Oakland with the intention of making brick for shipment to the steel mills of the eastern States, and other products will be manufactured by allied companies. The magnesite intended for brick will be burned in long, inclined, brick-lined steel cylinders, somewhat similar to those used for pyritic roasting. Crude oil will be used for fuel.

Description of Deposits.

The California magnesite deposits, so far as known, all occur as veins in serpentine, or similar magnesian rocks. By far the larger part are in the Coast Range, in the serpentines that stretch from Southern California into Oregon. These serpentines are probably Lower Cretaceous in age[a], and cover large areas, Becker[b] estimating that between Clear Lake and New Idria, a distance of about 200 miles, there is a total area of over 1,000 square miles of serpentine. Through a large part of this area magnesite veins of varying sizes are found.

[a] Fairbanks, Harold W. San Louis folio, No. 101, Geologic Atlas of the U. S., U. S. Geol. Surv., 1904, p. 6.

[b] Becker, Geo. F. Geology of the Quicksilver Deposits of the Pacific Slope. Monograph, Vol. 13, U. S. Geol Surv., Wash., D. C., 1888, p. 103.

Those large enough to be more or less workable are reported from many places in Mendocino, Napa, Placer, Sonoma, Alameda, Stanislaus, Santa Clara, Fresno, Tulare, Kern, and Riverside counties. Of these, the deposits in Placer, Tulare, and Fresno counties are in the foot-hills of the Sierras.

The serpentines of the Coast Range are ordinarily green or bluish, greatly broken and faulted, a solid block a foot in diameter being a rarity in many localities. They are derived from olivine-pyroxene rocks in which the amounts of the minerals have varying ratios at different localities. At Porterville, the only place along the Sierra Nevada Mountains at which the serpentines were seen, they also seem to be derived from an olivine-pyroxene rock. Instead of the usual green, the serpentine is here brown, and, as compared with the others described is remarkably solid.

Magnesite is formed from the breaking down of the serpentine, a hydrous magnesium silicate. Magnesia is dissolved by percolating waters carrying carbon dioxide, changed to the carbonate, magnesite, and precipitated in cracks and crevices as veins. The silica is carried away by the water and is often deposited in other veins as opal or quartz.

The magnesite frequently stands out prominently from the surrounding serpentine, since it weathers less readily than the serpentine, and the surrounding serpentine is generally considerably decomposed and so erodes rather easily.

Little is known of the depth to which the veins extend. Considering that they are formed through the influence of percolating surface water, it seems fair to assume that the deposits may extend down to the limit of circulation of these waters, their size being modified by the time through which such circulation has existed, differences in the hardness or composition of the rock, etc.

Cinnabar and chromite are frequently found accompanying the serpentines in the neighborhood of magnesite deposits.

Livermore Deposits.

Near Livermore, a town forty-eight miles southeast of San Francisco, are a number of magnesite deposits, of which the only one being worked is located thirty-two miles southeast of the former place and belongs to the American Magnesite Company.

An excellent road follows up the Arroyo Mocho, crossing into and running down the Arroyo Colorado. The maximum grade for the haul from the mine is said to be 3 per cent. At the mines the company has erected good buildings and roads and an aerial tram 2,500

feet long, with a capacity of 100 tons per 10-hour day, delivers the magnesite to bunkers, from which it is loaded into iron wagons for hauling to Livermore. The wagons carry 17½ tons each, and two are hauled by an oil-burning traction-engine. The magnesite is shipped to Oakland, where the company's factories for brick, carbon dioxide, and other products are situated. The mine offices and other buildings are located near springs that give sufficient water for the needs of the engines, the mine, and other purposes.

The magnesite veins stand out prominently in the bright sunshine of the valley and as they are almost dazzlingly white, they can be seen from the higher hills, miles away. One of the veins, called the "Mammoth," stands fully 10 feet above the hillside. Many of the veins, however, are largely covered by débris.

One of the veins shows an outcrop 40 feet broad and traceable through a distance of several hundred feet. Others show lesser outcrops, but the total amount exposed is large. However, in such outcrops but two dimensions are known and an estimate of the amount of magnesite available is merest guess-work.

Although these deposits have been known for a long time, they have not been worked until the past year owing to their distance from a railroad. There are a number of veins in a group around a small valley, so arranged as to be excellently located for working by adits and an aerial tram. The first magnesite was shipped from the mine in November. The vein that is being mined strikes about N 30 degrees W, dipping steeply southwesterly. It is pierced by several adits, on different levels, and a cross-cut at one place after entering the vein for 35 feet was not yet through it. A drill hole 8 feet long at the end of the cross-cut was said not to have reached the other side. The vein had been developed through a length of between 250 and 300 feet. The magnesite is pure and white, the cross-cut looking as if freshly whitewashed. As would be expected in a serpentine area, faults have occurred, cutting the vein in a number of places. Both hanging and foot-walls are fault planes.

Mining is carried on by means of an open cut in which the magnesite is quarried and allowed to fall through an upraise to an adit below, whence it is moved in cars to the aerial tram. The tram drops 600 feet in the 2,500 feet to the bunkers. The skips are placed 500 feet apart and each carries 1,000 pounds of magnesite.

Close to the magnesite veins about 250 yards southeast of the present workings are small impregnation veins of chromite. A small

FIGS. 1 & 2. OUTCROPS OF LARGE VEINS OF MAGNESITE.

The lower picture shows the Mammoth Vein on the American Magnesite Compan,'s property, 32 miles southeast of Livermore, Cal.; the upper one is a large vein on the same tract and in the same vicinity.

amount of work has been done on the veins but the prospects did not seem to have been encouraging.

A little cinnabar is said to have been found in the neighborhood, and two mercury mines are being developed within a radius of four or five miles.

Chiles Valley.

Chiles Valley is situated in Napa County, and its nearest shipping point, Rutherford, is eighty-four miles by rail north of San Francisco. Magnesite was mined by Stanley and Bartlett for twelve years in the valley at a point about 10 miles from the railroad, but the mines have not been operated for the past five years, being too far from the railroad to compete with points more advantageously located with regard to shipping facilities. During the time that the mines were worked many thousands of tons of magnesite were mined and burned at this place. As pure magnesite loses more than half its weight on burning, a large saving could be made in haulage by getting rid of the carbon dioxide, if the material was to be used as magnesia. Manzanita, a hard-wooded shrub making a hot fire, was largely used for fuel.

The country-rock here is also the Coast Range serpentine, somewhat more inclined to a blue-black color than at the Livermore deposits. The deposits are on the west side of the valley, in a small serpentine hill skirted by a public road, and consist of a number of veins varying in thickness from 1 foot to 6 feet, but are said to have reached as much as 12 feet. Wherever seen, however, the larger ones were much mixed with serpentine and other impurities. Much faulting occurs with the veins, and both the hanging and foot-walls are generally fault planes. The serpentine is much broken in the neighborhood of the veins, the interstices being filled by small veins of magnesite.

On the foot-wall of several of the veins extensive silicification has taken place, the serpentine being hardened through 2 or 3 feet. The veins are often brecciated and cemented with less pure material of yellowish color, while the original magnesite is a clear white. Frequently in the brecciated portions each fragment is covered by magnesite in radial crystals, forming a coating up to one-half an inch thick, and varying in color from crystal clearness to delicate green and yellowish-green. Cracks in the serpentine are also filled with the same crystalline magnesite. This form is strikingly different from the ordinary magnesite, which in these deposits shows no crystal form to the unaided eye. In places, crevices in the vein have a velvety

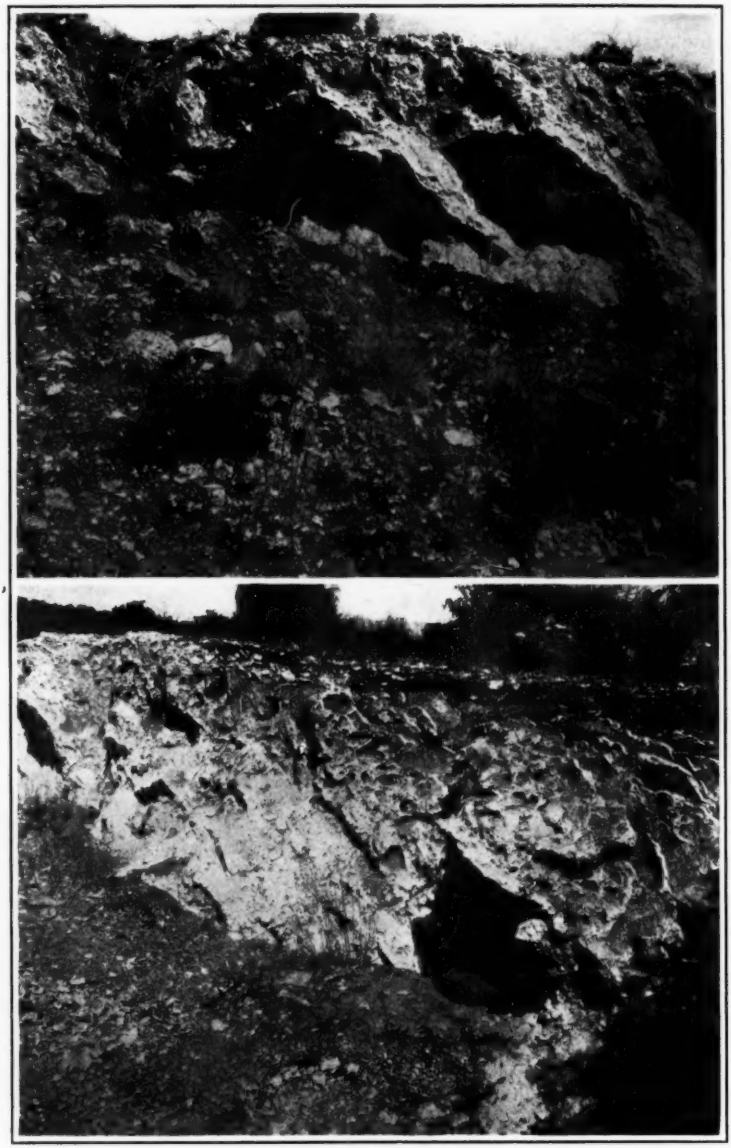
black coating of pyrolusite (manganese dioxide) making the rock look as if it were coated with lampblack. A small amount of chromite has been found in the neighborhood, but not in paying quantities. An analysis of magnesite from this mine is given further along in this article.

Pope Valley.

What is usually known as the Walters magnesite mine is located on the east side of Pope Valley, twenty-two miles northeast of Rutherford. The distance of the mine from the railroad makes hauling expensive, and the mine has never been worked on a large scale and has had no production for several years. A proposed electric road from San Francisco to Lake County, if built, will pass within four miles or less of the mine, in which case it will be in an excellent position to ship magnesite.

The deposits are situated in a serpentine hill, about 400 feet (barometric measurement) above the valley. They are composed of a large number of veins, whose exposures vary in width from a fraction of an inch to 12 feet, and lie on both sides of a small southerly running ravine which forms an amphitheatre, with an easy, straight grade to the valley, making an almost ideal place to work with an aerial tram.

The deposits are in three principal groups, two of which lie on the east side of the ravine and the other on the west. In the main group on the east side are three large veins of magnesite which can be definitely traced for distances of about 140, 250, and 230 feet respectively, with strikes of N 28 degrees, 30 degrees, and 45 degrees W. At their northern end the western and eastern veins are but 30 feet apart, with the middle vein probably converging with the eastern one. The dip of the western vein is shown by a shallow shaft to be 50 degrees easterly. The veins stand up boldly and can be seen from any part of the valley not hidden by hills. Longitudinal faults occur in both of the outer veins. Between the large ones are many smaller veins having a general parallelism to the main bodies. At its widest exposure the western one is about 10 feet thick, of which about 5 feet on the foot-wall is solid white magnesite, while the upper 5 feet (on the hanging wall side) contains many inclusions of serpentine. The structure of the east vein is similar, and in places the magnesite may be seen grading into the country rock. It is about 12 feet wide where exposed in a shallow cross-cut. In the middle vein a width of 18 inches to 5 feet of clear white magnesite is exposed. Some of these outcrops are shown in the photographs on the next page.



FIGS. 3 & 4. MAGNESITE VEINS OUTCROPPING AT WALTERS MINE, POPE VALLEY, CALIFORNIA.

There has been some crushing of the magnesite and the broken particles have been cemented with yellowish, less pure material. Part of the magnesite has formed in yellowish botryoidal masses that are rather impure. Some crystalline magnesite, similar to that of Chiles Valley, is found in the crevices. No large amount has been mined, and that was simply broken from the exposed faces of the veins.

A second group of veins with a more northerly strike occurs a hundred feet or more above the veins just described. The veins forming this second group are smaller, running from 2 inches to 2 feet in width, the larger ones impure. There are also many scattered veins in the intervening space.

On the west side of the ravine is a third group of veins 200 to 250 feet from those first described, with a strike between north and northwest. The largest is a vein 4 to 6 feet wide, and seven others from 1 to 2 feet wide occur within a space of 125 feet; all are of excellent quality. It would seem possible to blast out the whole of the rock through this distance and hand-pick it, should the deposits again be worked.

The Porterville Deposits.

The Willamette Pulp & Paper Company is working a large group of magnesite veins four miles northeast of Porterville, in the outer range of foot-hills of the Sierra Nevada Mountains. The veins occur in a brown serpentine, derived from an olivine-pyroxene rock with a structure resembling bedding. The serpentine forms part of a metamorphic complex of amphibolite-schist, serpentine, and other magnesian rocks, some talcose and mica-bearing, and a small amount of fine-grained quartzite. The rocks have a general northerly strike with a high dip (60 degrees) easterly. They are cut off by a granitic mass on the south, a few hundred feet from the deposits, and several granitic dikes cut the serpentine and other rocks. Basic dikes of several varities cut both the country rock and the veins, and are occasionally squeezed to schists.

Faulting is frequent and the magnesite in the larger veins is invariably crushed. In one vertical two-foot vein a couple of hundred feet southeast of the kiln, the magnesite has been so squeezed that it has taken a modified cone-in-cone structure; it is left in irregular fragments whose sides are covered with abrasion lines, and the whole looks as if at the time of crushing it had been in a semi-plastic state. In other veins the planes along which the magnesite has moved upon itself are smooth and shaped so as to somewhat resemble the curve of a highly arched shell. Along these planes is often a bright red stain of iron oxide, although the surrounding magnesite is pure

white. At the northern end of the deposits are several "blanket" or flat veins. The largest one is practically horizontal in the middle part and somewhat uptilted at both ends. It extends through the hill, a distance of 362 feet, and is probably twice as long, and from 2 to 4 or more feet thick. A basic dike flattens and spreads under a large part of the vein in a thin sheet 1 to 2 feet thick; then breaking through, it overlies the remainder of the vein.

FIG. 5. CRUSHED VEIN OF MAGNESITE, PORTERVILLE, CALIFORNIA.

There is nothing to show that the vein has been tilted from a more upright position to its present place and it was evidently formed as it lies, flat, and cutting across the vertical structure of the serpentine. This is accounted for by supposing that there was a slow movement in the rocks along this plane at the time of the vein's deposition, the magnesite filling uneven open spaces along the horizontal fault, and when there was another movement these depositions would hold the mass apart and make room for contiguous deposits. The crushed condition of the whole mass, and inclusions of serpentine in lines approximately parallel to the sides of the vein, give this hypothesis some color. Other "blanket" veins lie at rather low angles and will probably be found to run into this one. At the north end of the deposits

is a stockwork of small veins 2 to 6 inches thick, and it is thought that it may pay to blast the whole mass and hand-pick it.

With the exception of magnesite shipped to the Western Carbonic Acid Gas Company, of San Francisco, for making gas, all of the magnesite mined here is burned before being shipped. Crude oil is used for fuel, and the magnesite is fed into the top of a kiln, gradually rising in temperature until it reaches the flame from the burners. It is then raised to a white heat and kept there for from 20 to 25 minutes when it is withdrawn. Shipments are made from Hilo, a spur on the Southern Pacific Railroad, one mile north of Porterville.

Magnesite is much easier to calcine than limestone, as it gives up all of its CO_2 at 510 degrees C. (950 degrees F.) while limestone demands a heat of 825 degrees C (1,517 degrees F).

FIG. 6. MAGNESITE AND "BLANKET VEIN" IN FOREGROUND STOCKWORK OF VEINS IN BACKGROUND. PORTERVILLE, CALIFORNIA.

Manufacture of Liquid Carbon Dioxide.

At the time of my visit the Western Carbonic Acid Gas Company of San Francisco, with works across the bay at Sedan, or Emeryville, were the only manufacturers of the gas from magnesite, although one of the subsidiary companies of the American Magnesite Company was erecting a plant at East Oakland (Clinton).

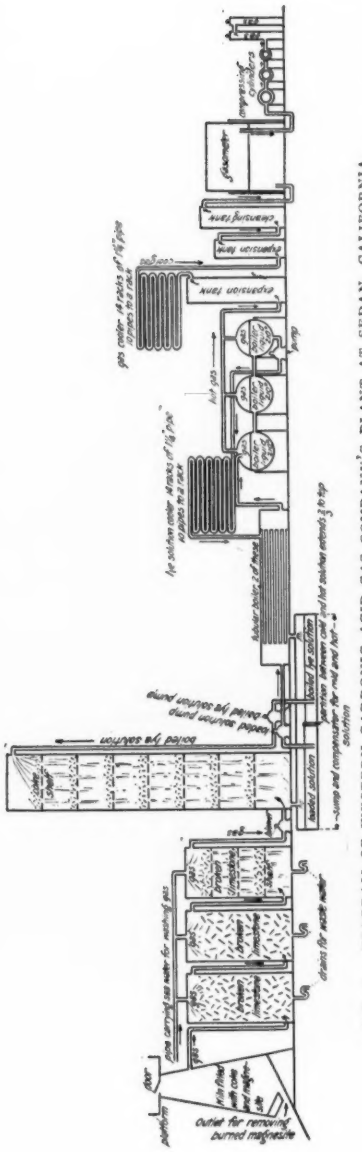
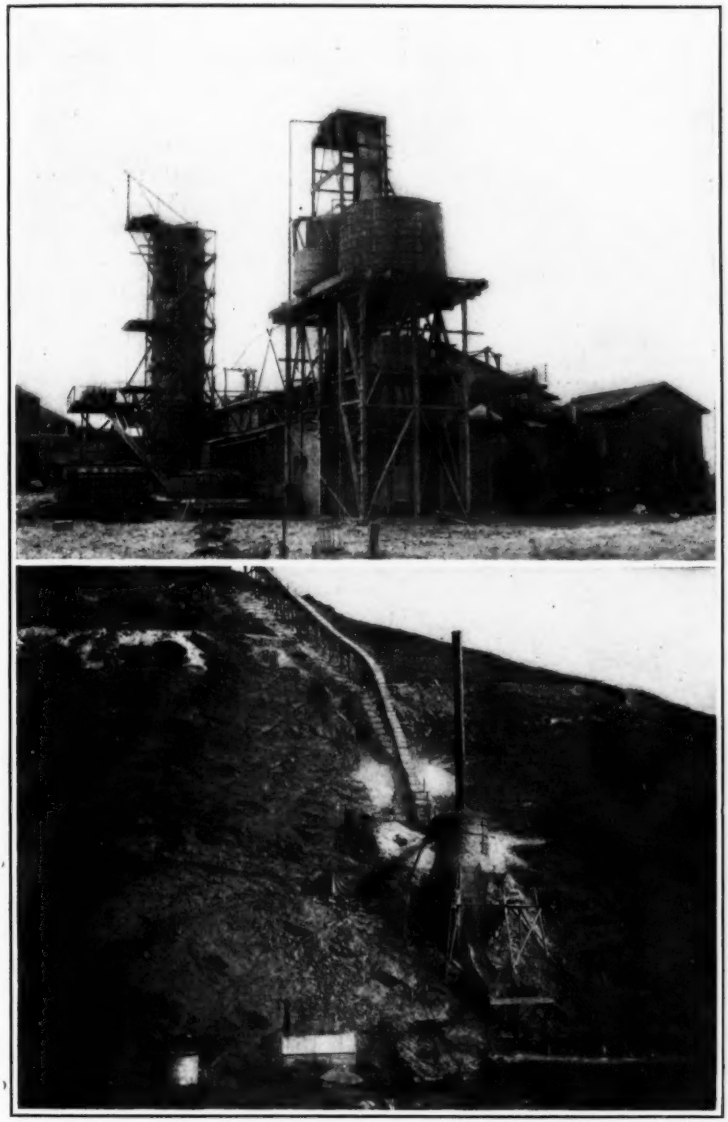


FIG. 9. DIAGRAM OF WESTERN CARBONIC ACID GAS COMPANY'S PLANT AT SEDAN, CALIFORNIA.

The magnesite is burned in a kiln with one-tenth its weight of coke, and the gas is pumped into scrubbers, of which there are three, filled with broken limestone to counteract any sulphuric acid formed, and washed with sea water. The gas then passes to an absorption tower where it comes in contact with a sprayed solution of potassium carbonate, by which it is absorbed. The "loaded solution" is then pumped into boilers where it is raised to a temperature just below the boiling point of water. The solution gives up its gas and is pumped back to the absorption tower while the gas is pumped through cleansing tanks to a gasometer. It is then compressed in a three-step compressor to the liquid state and is shipped in steel cylinders holding 25 to 60 pounds. In this process the weight of gas obtained is about 5 per cent. of the weight of the magnesite used. The gas is shipped all over the Pacific Coast and the southwestern States. It is used in refrigeration and in making soda water and other carbonated beverages.

The diagram on this page will probably make the process clear.

This same company is preparing to make light *magnesia alba* by the Pattinson process, to



FIGS. 7 & 8. PLANTS FOR THE TREATING OF MAGNESITE.

The lower picture shows a kiln at the magnesite mine Porterville, Cal.; the upper one shows the plant of the Western Carbonic Acid Gas Co., Sedan, Cal.

be used as an absorbent for nitroglycerine in the manufacture of dynamite. It is said to make a very superior absorbent for the best grades of dynamite.

The following table of analyses will give some ideas of the purity of the magnesite from the different localities described:—

ANALYSES OF MAGNESITE AND MAGNESIA.

	1.	2.	3.	4.	5.	6.	7.	8.
Silica (SiO_2)	0.10	0.50	1.10	3.30	2.48	*a*1.81	*a*6.68	*a*0.90
Iron Oxide (Fe_2O_3)	.25	.30	.47	7.25	6.02	.08	15.10	.49
Alumina (Al_2O_3)	.....	....	.76	.84	1.18			
Lime (CaO)	.62	.70	.....	2.48	4.34	Trace	.....	1.49
Magnesia (MgO)	47.10	46.90	97.35	84.72	84.56	46.55	37.23	44.39
Carbon dioxide (CO_2)	51.98	51.60	.....	.....	.....	51.25	40.98	50.06
Water and undermined	.....	.....	.32	1.40	1.33	.32	.....	2.57
	100.05	100.00	100.00	99.99	99.91	100.00	99.99	99.90

a Insoluble.

1, 2. Alameda claim, American Magnesite Company, 32 miles southeast of Livermore, Cal.
3, 5. Same, calcined.
6. Chiles Valley.
7. Same, poor; not shipped.
8. Porterville;
Analyst, Nos. 1–5, unknown; 6–8, Abbot A. Hanks, 531 California street, San Francisco, Cal., October 1, 1903.

EXPERIMENTS ON A CONSTANT-PRESSURE GENERATOR.

By C. M. Garland.

The close relation between Mr. Garland's studies and those of Dr. Lucke, preceding in this number, will be at once apparent. The two investigators have been working in separate departments of a single problem — that of the gas turbine — Mr. Garland in the production and Dr. Lucke in the utilization of the fluid medium by which the gas turbine might be driven. The subject is probably the most actively interesting one in the whole field of dynamic engineering at the present moment, and Mr. Garland's results, like Dr. Lucke's, are the outcome of direct, practical, pioneer work.—THE EDITORS.

IN studying the question of the gas turbine, the first and possibly the only practical solution that presents itself is that of a turbine operating on a constant-pressure cycle. Such a turbine may be divided into turbine wheel and pressure generator. As is well-known, this cycle of constant pressure, from a theoretical standpoint, offers a very poor efficiency. However, looking at the question from a practical point of view, certain considerations enter which would seem to make investigation along this line worth while. So, in the fall of 1905, through the aid of the Engineering Experiment Station of the University of Illinois, I was able to design and construct, in the mechanical engineering laboratory of this institution, a small experimental pressure generator of a type presently to be described.

In designing a pressure generator to be used in running a turbine wheel, as suggested above, the question of temperature control is the first to present itself. There are at least two practical methods of controlling this temperature resulting from combustion: One, by mixing a quantity of cool air with the hot products; the other, by allowing the excessive heat of the products of combustion to be absorbed in the generation of steam, the steam being mixed with the products and passing with them to the turbine.

Looking at these two methods of control from the standpoint of high efficiency, it would seem as though the former would offer the best results in this respect. However, there is a certain very serious consideration that must be taken into account, which would seem to

render very doubtful the efficient operation of a turbine and generator using this method of temperature control. Especially is this true if the gases are to be conveyed for any distance. This consideration is the low specific heat of air, or of the products of combustion. Owing to this low specific heat, a very small amount of heat lost in radiation, conduction, etc., will represent a very large proportion of the total energy available in the gases, and will consequently lower the efficiency accordingly.

This loss is much greater than is ordinarily supposed, and makes extremely doubtful the efficient use of heated gases outside of the combustion chamber. In the case of the gas engine, the combustion takes place in the cylinder in which the gases are used, with the result that during combustion the cylinder walls, piston head, etc., store away quite an appreciable amount of heat, which is later given out and utilized when the gases begin to cool down through expansion.

In this second method of temperature control, by the generation of steam from the excessive heat of the products of combustion, and the admixture of this steam with the products, the disadvantages caused by the low specific heat are to a large extent overcome. Owing to the high specific heat of the steam, the specific heat of the mixture will be comparatively high. It is also quite likely that the presence of the steam will have a tendency to increase the amount of work done by the mixture as a whole. This will be due to the fact that in adiabatic expansion through any range of pressure, the temperature-drop of gases of low specific heat will be greater than the temperature-drop of the steam through the same range, as shown by the formula

$$\left(\frac{p}{p'}\right)^{\frac{k-1}{k}} = \frac{T}{T'}$$

Where $(k-1) \div k = (1.41-1) \div 1.41 = 0.29$ for air and $(1.33-1) \div 1.33 = 0.25$ for superheated steam. The result of this will be that the expansion curve of the mixture will lie above the expansion curve of air or products of combustion, and a greater amount of work will be obtained from the mixture than would have been obtained from the same weight of air expanding under the same condition of pressures, and initial temperature.

With these points in mind, it was decided to construct a generator

using the second method of temperature control, and in which the amount of water-heating surface could be varied, with the expectation of obtaining some idea of the correct proportion of steam to products of combustion for the highest efficiency.

The following is a description of the apparatus. Figure 1 is a sketch of the generator with oil and feed-water tanks. Figure 2 is a sketch of the nozzle used for spraying the air and oil. Figure 3 shows a section through one of the tubes. Referring to Figure 1, A is the generator, B the feed-water tank, and C the oil-supply tank. The generator was built up of 12-inch extra heavy pipe fittings, extra heavy in order to withstand any explosions that might occur. 1 is the nozzle by which the amount of air and oil entering the combustion chamber is regulated; 7 the combustion chamber, lined with a mixture of burnt fire-brick, ground and united with fire clay; 6 is the tube sheet into which are expanded the tubes, 8. These are 73 in number, ⅝-inch in diameter and 22 inches long, with .042-inch thickness of metal. The upper ends of these tubes are free. Into the end of each was dropped a ⅜ by 1½-inch bolt, as shown in Figure 3. Directly above the tubes was placed a perforated plate, 9, to prevent the bolts being blown out of the tubes. The object of this arrangement was to prevent the water lying around the tubes, in case of violent ebullition, descending through the tubes into the combustion chamber. The products of combustion pass up through the tubes, mix with the steam, and pass with it out through the valve 20. The valve 20 was in a horizontal position in the generator as constructed, and a thermometer for taking the temperature of the gases was located in an ell between the valve 20 and the generator. 4 is a ¾-inch nipple fitted with an eyepiece 27, for observing the combustion. 17 is a 1½-inch pipe plug. The generator was fitted with gauge glass, pressure gauge, blow-off cock, etc. C is the oil-supply tank, the oil being forced into the combustion chamber by air pressure admitted to C through valve 24. B is the water-supply tank. The water is also forced into the generator through air pressure acting through valve 14. The manner of operating was as follows: Relief valve 25 was opened and water admitted through valve 26. The tank being filled, 25 and 26 were closed and 14 opened. When it was necessary to feed water to the generator, valve 15 was opened.

The manner of operating the generator was as follows: Compressed air at 110-pounds gauge was supplied to nozzle, oil tanks,

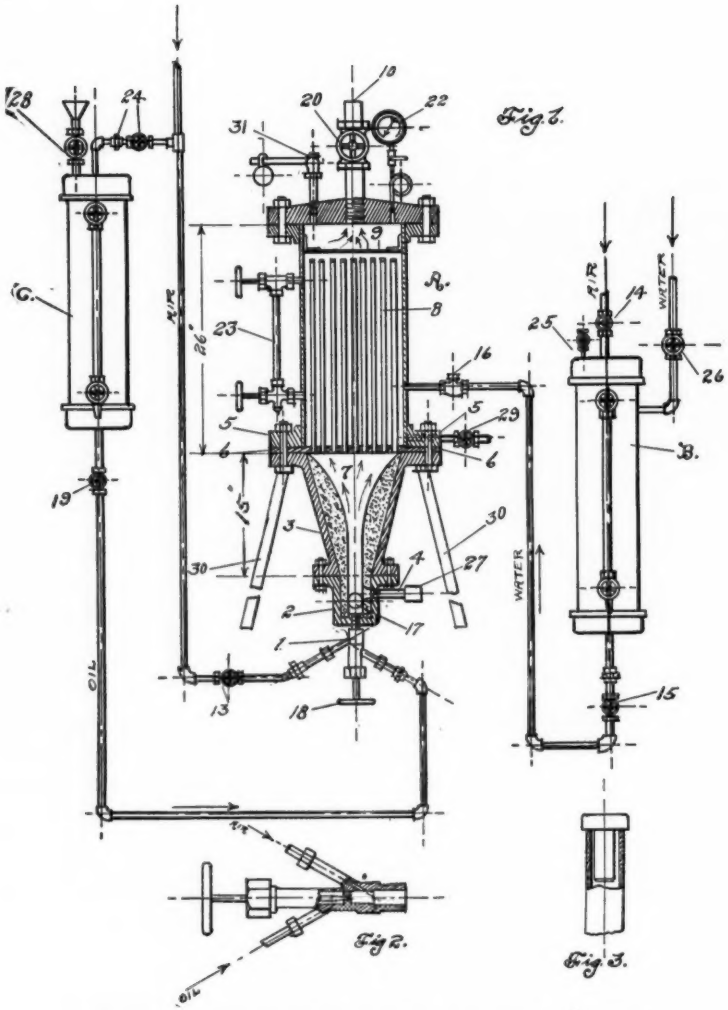


DIAGRAM OF EXPERIMENTAL CONSTANT-PRESSURE GENERATOR.

Fig. 1, Generator, with oil and feed-water tanks; Fig. 2, nozzle used for spraying air and oil; Fig. 3, section through one of the tubes.

and feed-water tank. Kerosene oil was used in all experiments for fuel.

Two methods of starting were tried. The first method was to open valve 20, remove pipe plug 17, pour a small quantity of gasolene into the combustion chamber through opening 17, and ignite by means of a torch. Then slowly turn on the air through nozzle 1 by means of valve 13. After the gasolene had burned for a few seconds, kerosene from tank C was slowly turned on by operating needle valve 18 in nozzle 1, and a bright, steady flame obtained by manipulating this valve (18). It required considerable practice to do this, but after a time it became quite an easy operation. After the flame had continued steady for a few minutes, the pipe plug 17 was replaced by means of a socket wrench, and pressure of 100 pounds gauge was obtained in the generator by throttling down the gases escaping through valve 20. This manner of starting proved to be very satisfactory, more so than the second method, which was as follows. Air pressure of about 60 pounds was maintained in the generator, and a series of sparks started by means of a suitable spark plug, over the mouth of the nozzle, and the oil slowly turned on. In using this method of starting, the burner must be heated up, or else a start with gasolene made by having an auxiliary gasolene reservoir connected with the nozzle. After the chamber is heated up, the gasolene may be turned off and the kerosene turned on. This method of starting would probably be satisfactory if a suitable ignition device were at hand. In the present case an ordinary spark plug was used, and burned out in a short while.

After pressure was obtained in the generator, the combustion was regulated by observing the flame through eyepiece 27, and manipulating valves 13 and 18, until the flame was of a brilliant white. In this way combustion was made very complete. However, it was found that under the best condition possible with this apparatus, a few small particles of carbon would come over in the gases. This was probably due to the large amount of water-heating surface and the short fire-box or combustion chamber. With a combustion chamber properly proportioned, it is believed that this trouble would be completely eliminated. After the generator had been in operation for about thirty minutes, steam would begin to come off and the pressure to rise so that it was necessary to open up gradually the throttle valve 20, in order to prevent the generator pressure rising to that of the compressed-air supply.

The points to be determined in constructing this apparatus and carrying on the experiments, were:—

First, to determine if this form of generator were practical, and if so what obstacle would have to be overcome in placing such a generator in commercial form.

Second, to determine if possible what efficiencies might be expected from a plant using this form of generator.

As to the first question, so far as the practical operation of such a generator is concerned, within the range of pressure and temperature used, no serious difficulties have to my mind presented themselves. There were a number of troubles encountered, such as sputtering of the flame on starting, incomplete combustion, melting out of the fire-brick lining, etc., all due principally to incorrect proportion of parts. After the generator was once heated up, and the supply of air and oil regulated, there were no other troubles. The combustion seemed to be, and evidently was, much more intense under pressure than it would have been at atmospheric pressure. The higher the pressure the more intense the combustion, and possibly the more efficient. The temperature reached in the combustion chamber must have been very great, as the fire-brick lining, after a two-hours' run, melted out and covered the mouth of the nozzle to a depth of three or four inches. Owing to this difficulty the experiments were brought to a temporary close until a different form of combustion chamber could be constructed.

The highest temperature reached by the gases above the tubes was 600 degrees F. The temperature of the gases seemed to vary considerably, all the way from 450 degrees F. to 600. This low temperature was due to the large amount of water-heating surface and the small diameter of the tubes. The question of temperature regulation is one that at the present time need not be considered, as the amount of water-heating surface will tend to keep the temperature constant, and within reasonable limits.

The pressure used, as above stated, was about 100-pounds gauge in the generator. The pressure of the compressed-air supply was 110 pounds. The regulation of the pressure was found to be a comparatively easy matter, and no doubt could be made automatic for varying loads. The reason for this belief is, that after a certain proportion of air and oil is reached, necessary for complete combustion, a still greater quantity of air, seemingly, will not affect the combustion; it is therefore evidently unnecessary to regulate the air with

any great degree of accuracy, it being sufficient always to keep the amount of air at or above that quantity necessary for complete combustion. This statement has been found to be practically true in the case of the generator under consideration. After the proper proportion of air and oil necessary for complete combustion was reached, a still greater quantity of air could be admitted without producing any other effect than a slight lowering of the temperature of the gases.

The second question to be determined was that of efficiency. Two generator tests of one and one-half hours each were attempted, and one engine test. Owing to the linings melting out and causing trouble with the nozzle, no accurate results were obtained. Such as they were, however, they indicated a very high efficiency considering the size of the apparatus, and served as a stimulus to further investigation. At the present time a new combustion chamber is being constructed, and as soon as it is completed, experiments will be resumed, with the object of determining some idea of the efficiency, the proper proportion of steam and products of combustion, and the form of turbine best adapted to be used with this type of generator.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

VII. SPEEDS AND FEEDS.

With this article Mr. Becker closes for the present his study and discussion of the introduction, treatment, and use of alloy-steel tools. His series began in THE ENGINEERING MAGAZINE for September, 1905, and extended at that time to a group of four articles, taking up successively the general outlines of the problem, controlling principles in introducing the steel into the shop, working directions for making and treating tools, and the design and operation of tools and machines. In the supplementary series now concluded he has considered the range of adaptability of alloy-steel tools, the "Tool at Work", and now the extremely important question of speeds and feeds.—THE EDITORS.

THE conditions under which metal-cutting tools work are so various that it may well be doubted if any generalizations could be made with respect to feeds and speeds which would be applicable in any considerable number of given cases. Some conditions are undoubtedly fundamental—the inter-relation of feed and speed, for instance; but most of the other elements vary so much that there is likely to be confusion and uncertainty in the application of formulas to specific jobs. The very fact of such a multitude of conditions and variants, however, makes it necessary, in a discussion of this subject, to bring out of the great mass of individual experiences some sort of generalizations which may be useful as guide marks or criteria, to which certain classes of jobs may be referred with the expectation of realizing a reasonable degree of efficiency; the conditions being later modified as experience may indicate. The mere recital of experimental results serves small purpose outside of showing, perhaps, the possibilities under given circumstances. Thus there is little significance in the statement that a certain tool cut soft steel in a lathe at the rate of two hundred feet a minute. But if it can be shown that under a given set of conditions susceptible of approximate duplication in a pretty well defined group of jobs, a tool can be expected to do a certain amount of work, something is gained which may be used as a basis of comparison for all jobs falling within the classification so de-

fined. It is the purpose in the present discussion to develop such classifications, very elastic and only approximate of course, but found by experience to serve this purpose.

Four elements have been previously mentioned as fundamentally affecting the efficiency of a tool, namely, first cost, accuracy of work, cost of maintenance in an efficient state, and endurance. There are of course many other factors, more or less incidental and dependent upon the conditions involved. Obviously the endurance of a tool, or in other words, the total amount of work it is capable of doing, is the most important single test of its efficiency.

Now the amount of work done by tools of the kind under consideration is simply the quantity of metal removed in a specified time, whether that be the whole life period of the tool or a shorter time. The problem then becomes one of how much of a cut can be taken continuously, and at what speed. The problem in this form ignores such factors as the strength and powering of the machine in which the tool is used. For the purposes of this discussion these elements need not be considered, since it is assumed that the tool is to work in a machine capable of driving it at its highest efficiency. Working under less favorable conditions merely involves a reduction in efficiency corresponding with the reduced capabilities of the machine.

The amount of metal that can be removed in a given time is limited also, in the case of high-speed cutting tools, by the combined capacity of the tool, the chip, and the piece being tooled, for carrying away the heat generated in the cutting. These tools, as already stated, not only work well when hot, but even require a preliminary warming up before they can do their best work. Nevertheless the heating cannot go too far, without injury, and it is necessary to make the conditions such that the heat can be conducted away so that the cutting edge does not reach a temperature high enough to show any red color. It is true that some tools have been found to work well even when showing some red; but in general it is not safe to work a tool to this extent. At such a temperature the critical point, at which the edge begins to crumble more or less, is not far away.

Now the chief factors that affect the generation of heat at the cutting edge are the size and shape of the tool, size and shape of the chip, speed at which the cut is taken, toughness or hardness of the material, and method of lubrication or cooling agent, or lack of it. In the case of cylindrical cutting the diameter may also become a factor. Whence the endurance, that is to say, the efficiency, of the tool depends upon a

proper adjustment or balancing of the factors just named. Where the machine itself is relatively inefficient, there is of course a further adjustment to be made, compensating for this. The relation of these factors is easily seen in the formula

$$\frac{S \times F \times D \times H}{T + L + C}$$

in which S, F, D, H, T, L, and C represent respectively the speed, feed, depth of cut, hardness or toughness of the material and chip, conductivity of tool, lubrication, and conductivity of the material and chip. It is possible to classify jobs in such a way that for each class the last four of these elements become approximately fixed, leaving only the cutting speed, feed, and depth of cut to be determined. These are likely also to be somewhat affected by the diameter of the finished piece, as already pointed out.

In the manufacturing shop (as distinguished from the engineering shop)—that is, in the shop wherein pieces are reduplicated in large numbers—even the depth of cut becomes a constant for practically all kinds of jobs upon similar materials. Thus, as shown in the previous article, gray-iron castings should be over-sized enough to allow for a cut of about $\frac{1}{16}$ inch in depth, except in the case of pieces of unusual shape, easily warped or susceptible of bad coring, when a greater allowance should be made. So also with other materials, for the most part; the depth of cut is regulated by the size of the material selected, and can be made practically constant outside of the relatively few exceptional cases. In the engineering or tool-making shops, however, there is certain to be much variety in the amount of material to be removed, so that this continues to be a variable.

Let us see how the problem works out in the case of gray-iron turning.

Starting with the depth of cut indicated, $\frac{1}{16}$ inch; omitting, as usual in gray-iron working, a cooling agent; assuming the tool to have been shaped and sized so that the conductivity of tool and chip may be disregarded; and taking metal of average or medium hardness, the only factors remaining to be determined are the feed and speed. These vary (all other elements, such as size and shape of tool, for instance, remaining constant) inversely with each other; so that any increase in one implies a decrease in the other.

There are certain limitations in respect to feed that permit comparatively little latitude. With tools of the ordinary shapes it is

obvious that a heavy feed produces a rough finish; and since most work of the sort now under consideration must be done with a single cut, it is necessary to select a feed that will leave a satisfactory surface. Anywhere from $\frac{1}{16}$ to $\frac{1}{8}$-inch feed will do this, the exact amount being easily ascertained in practice. Theoretically a variation so great as this would seriously affect the possible cutting speed. Practically, however, it is of little consequence. If the tool were being regularly speeded to its limit, of course such doubling of the feed would at once affect the life of the tool (that is to say, of a grinding) and necessitate a corresponding decrease in the speed; but in practice the speeds used are far under the highest limits, chiefly for the reason that the tools are rarely used in machines capable of working them to their maximum capabilities, and that it is often inconvenient to handle materials fast enough to keep up with the tool. At the speeds found most practicable under present conditions, a change of $\frac{1}{16}$, say, in feed, does not affect the number of grindings sufficiently to be noticeable. Under the conditions given it is shown very conclusively in laboratory experiments and tests, as well as practical shop experience, that for work of moderately small diameters (say up to 5 inches) a speed of 65 feet per minute is as great as can be continuously maintained without too frequent grinding of the tool. On work of larger diameter the speed can be increased 10 to 15 per cent, because the direction of the cut is not changing so quickly and the chip therefore does not need breaking up or curling so rapidly. Furthermore, in gray-iron castings the smaller pieces commonly chill more or less even in sand molds, and the light cut required scarcely does more than remove this skin of chilled iron—which is of course much harder on a tool than a deeper cut would be. In large parts there is little or no appreciable chilling of this sort, and the material cuts with correspondingly greater ease. In all cases also where the skin of scale and hard iron has been removed, a considerable increase in speed is attainable. Thus in experimenting in turning operations upon a large drum, after the first skin cut a speed of 125 feet per minute was maintained as long as it was interesting to observe it, without damage to the tool. Such a speed is often attained in tests under more trying conditions, but in actual practice is rarely as efficient as the slower speeds indicated.

As for work requiring heavier cuts, say up to $\frac{1}{2}$-inch depth, allowing a feed of about $\frac{1}{8}$ inch, a speed of 45 to 50 feet per minute can be maintained without trouble. Such cuts would obviously be taken on

pieces of relatively large size only, say 6 inches diameter, and over. Under exceptional conditions 90 feet per minute have been maintained for long periods of time.

Extra hard gray iron can be turned at 25 to 35 feet per minute, as shown in the curves (Figures 1 and 2). Chilled iron may be finished at anywhere between 3 and 12 feet per minute. It is really of small consequence anyway, because most of the time in this kind of work is used in changing the tool and sharpening it. A tool that will hold up at 3 feet per minute will also hold up at 12 or even more.

Obviously there will be variations in speeds corresponding to variations in feed and depth of cut between the largest and smallest section of chip specified in the above. The curves in Figures 1 and 2 are useful for determining the speed practicable in most cases, not only in machining gray-iron castings, but also the other materials named.

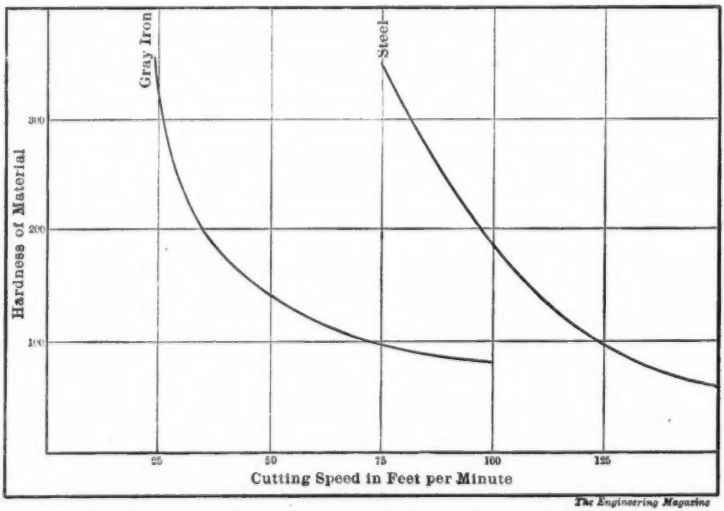


FIG. 1. CURVES SHOWING THE EFFECT OF INCREASING HARDNESS IN MATERIAL UPON THE SPEED PERMISSIBLE TO A TOOL, FOR EFFICIENT SERVICE.

100 is taken as the standard for moderately soft material, and 400 as about the limit of hardness as usually handled in manufacturing.

On steel speeds as high as 247 feet per minute (cut ¼ by ⅛) have been attained for short times—and this on 0.4 per cent steel. On such steel, however, 100 feet is all that can be desired for continuous performance, and 75 to 85 feet is in practice very satisfactory. In one instance 0.6 per cent steel is turned at a speed of 72 feet, feed 1/32, cut

⅜, diameter of shaft 2 inches; but so far as reported nobody else is able to do the same thing continuously—for the reason probably that in this case the job is done under exceptional conditions as to lathe, shape of tool, etc. Ordinarily 50 feet is very good speed for a job of this sort.

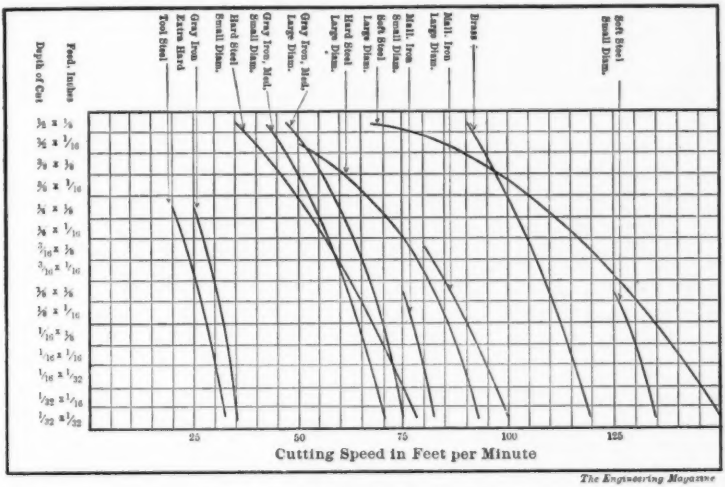


FIG. 2. SPEEDS SUITABLE FOR VARIOUS FEEDS AND DEPTHS OF CUT, IN TURNING OPERATIONS.

For milling operations add 50 per cent to the appropriate speeds indicated above, taking care to apply the selected speeds to feeds for which they are suited. For boring subtract 10 to 40 per cent and for drilling and reaming, see table of drill speeds and feeds on the following page. The "small diameters" refer to those under 5 inches.

Low-carbon and machinery steel can be turned (in large diameters and with light feed and cut) as fast as 150 feet per minute, and sometimes even faster. In heavy cutting, say ⅜ to ½-inch depth by ⅛-inch feed, 65 to 70 feet is all that can be recommended ordinarily.

In malleables, 80 feet is about all that can be expected on small work. This of course is practicable only in the case of light feeds and cuts, which are the only kind that should be taken on parts of this material, for reasons already given. On larger pieces the speed may reach somewhat above 90 feet, and under exceptional conditions, 100.

Speeds for brass and the other soft metals, as may be seen, are considerably greater than for soft steel. The highest speeds given for soft steel usually are much too great for bronzes, however, which curiously enough allow a speed scarcely ⅔ as great as that for soft steel.

It has doubtless been observed that the speeds and feeds thus far indicated are those suitable in turning operations. Except only in milling, where the teeth of the tool cut intermittently and have plenty of time to cool off, turning operations permit greater speed than any others involving the cutting of metals. It is necessary therefore to make suitable allowances in the case of other operations. Internal cutting with a boring bar, for instance, must be considerably slower than external turning of the same diameter. In regular turning the tool has ample clearance and can ride more or less on the finished surface, whereas in the case of internal cutting this is impossible. And furthermore, in order to obtain the requisite clearance from the concave finish, the point of the tool is necessarily more acute or else has less rake than is allowed by external work. Either condition involves a loss of efficiency, and therefore necessitates reduced speed. From 10 to 15 per cent reduction in speed as compared with external work may be expected, with a very rigid bar—otherwise the loss is more likely to reach 40 per cent.

SPEEDS AND FEEDS FOR DRILLS.

Size of Drill.	REVOLUTIONS PER MINUTE.					Feed per Revolution.
	Steel.	Mall.	Cast.	Brass.	Tool Steel	
1/16	4015	4620	4820	7650	1970	.001-.002
1/8	1850	1925	2220	3515	906	.002-.004
3/16	1380	1610	1650	2810	675	.003-.006
1/4	1040	1190	1250	1970	506	.004-.008
5/16	855	982	1028	1620	420	.004-.008
3/8	782	806	836	1330	342	.005-.010
7/16	604	688	720	1140	295	.005-.010
1/2	527	605	632	1003	258	.008-.016
9/16	425	488	512	807	210	.008-.016
5/8	347	410	420	666	173	.008-.016
3/4	300	346	360	568	146	.008-.016
1	260	298	312	495	128	.010-.020
1 1/8	228	264	276	436	112	.010-.020
1 1/4	215	248	260	410	106	.010-.020
1 3/8	200	230	238	380	98	.010-.020
1 1/2	178	205	216	342	92	.010-.020
1 3/4	154	173	180	290	73	.010-.020
2	130	150	156	246	64	.010-.020

These speeds involve peripheral speeds of 60 to 65 feet per minute, in soft steel. For reamers, only about half the above speeds are permissible. The feed per lip is preferably the lighter one given in any particular size. For taps and dies about the same speeds may be used as for reamers.

Much the same is true in the case of rose reamers, and to some extent of twist drills, although in practice it is unnecessary to take this into account—chiefly for the reason that there is scarcely a machine built (if indeed there be one at all) that will speed a drill of this sort

to its limit. The most satisfactory practice in drilling gray iron allows a peripheral speed of about 65 to 70 feet per minute and a feed of .008 to .020 inch per revolution, in the sizes of ½ inch and above. This is somewhat faster than the common practice, but gives good results.

Twist drills have ample rake at the cutting lips and therefore can run much faster than reamers, in which latter the chip butts squarely against the front side of the cutter and thus imposes a heavier duty. The speeds given in the table herewith have been found to be good practice in a great variety of materials and conditions. An examination of the table will show that the peripheral speed of small drills is slightly greater, in general, than that of larger ones. This is found to give greater efficiencies than were obtainable with the method of allowing uniform peripheral speeds. Inasmuch, however, as most drilling jobs, especially the small diameters, are done on hand-feed presses and machines, in which the feed is merely a matter of the operator's judgment, or more likely of his strength of arm, the question of feed is of small moment for the great majority of jobs of this character. On jobs where a forced feed is used, of course it can be regulated to conform to good practice, as shown in the table.

Reamers can safely be run at speeds about half those named in the table for the several diameters. In this case, however, forced feeds are much more commonly used, and always in the larger diameters, so that the matter of feeds becomes of consequence. In using the table it is to be remembered that the feed given is for two-lipped drills; whence the formula for deriving the proper feed is

$$\frac{F \times L}{2}$$

where F and L are the stated feed and the number of cutting lips respectively. This gives, for a 2-inch six-fluted reamer, a speed (in gray iron) of 78 revolutions per minute and a feed of .3 inch per revolution. It is not safe to use with reamers the heavier feeds specified for drills, the lighter feed being the most satisfactory.

The highest practicable speeds attainable in metal cutting are reached in milling operations. The reason plainly is that the individual cutting edges work during a small fractional part of the time required for a revolution, the remaining time serving to cool them; and since one of the chief elements in the efficiency of a tool is the ability to keep the temperature below the critical point, this circumstance gives milling cutters a great advantage. Indeed, as compared with lathe tools, the advantage—that is to say, the practicable increase

in speed at the cutting point—is something like 50 per cent. Obviously, also, the larger the diameter of the cutter (within limits) the greater the allowable speed, and therefore the greater the proportionate advantage. Generally, however, this may be disregarded.

The peripheral speed allowable to a properly proportioned milling cutter is therefore (on medium gray iron) about 90 feet per minute, with a depth of cut amounting to ⅛ inch and a feed of .01 inch per cutting tooth. Anything heavier than .01 is allowable of course only on cutters of moderately large size having teeth with plenty of clearance. Higher speeds than that given are sometimes used, but rarely with good results. In fact, it is generally better to use a speed somewhat lower and to take a rather heavier cut.

With the basis given, the speed and table feed for any milling tool may easily be worked out. The number of revolutions follows from 90÷C, in which C equals the circumference of the cutter in feet, and 90 the accepted cutting speed, also in feet. The table feed is derived from the formula T=N×R×F, where T is the table feed, N the number of teeth, R the revolutions per minute, and F the allowable feed per cutting tooth, which may be about .01, as already stated. Taking a miller of say 9 inches diameter and with 30 teeth, we have the following:

$$C=\frac{9\times 3.1416}{12}=2.3637 \text{ feet;}$$

and R (number of revolutions per minute)=90÷2.3637=38.

Also, T (table feed per minute)=30×38×.01=11.4 inches—which is more than most machines will stand. In such case, of course, either speed or feed may be reduced, as the nature of the job may suggest.

It should be said here that the amount of feed is to be regulated largely by the kind of surface required. A milling cutter will generally stand all the feed the machine will pull; but coarse feeds make rough surfaces, and the table feed is therefore limited by the requirements as to accuracy and smoothness of the finished surface.

Of course, as in the case of other tools, allowance has to be made for the kind of material, in fixing a practicable peripheral speed. Those found most generally efficient are: gray iron, 90 feet per minute; malleable, 86; steel (soft), 75; tool steel, 37; and brass, 140. This is for a table feed of .01 inch per tooth per revolution, or less; and a depth of cut not much exceeding ⅛ inch.

It does not seem worth while to give a table of speeds for mill-

ing cutters, since the conditions vary so greatly. By the use of the basic speeds for the various materials as just given, in connection with the formula used above in the illustration of the case as applied to gray-iron castings, there should be no difficulty in determining the speeds suitable in particular cases.

As to planer and shaper work, it is perhaps necessary only to point out that the tools will do anything the machine may be capable of. The few new machines of this type that undertake to give the high-speed tool a chance allow a maximum of about 50 feet per minute on steel. Older types of machine cannot get much more than half this without much burning up of belts and a great deal of racking in reversing.

Taps and dies may be run as fast as the material can be taken care of; which, with ordinary thread pitches, will give peripheral speeds approximately half that given in the table of drill speeds. For some of the materials used even this must be greatly reduced, for the reason already given.

In conclusion it may be pointed out (though it is perhaps so obvious as scarcely to need it) that the last word has not yet been said as to speeds and feeds for alloy-steel tools. The wonderful capabilities of high-speed steel, as shown in experimental tests and also in many instances of practical shop work, indicate very clearly that the relatively ordinary work to which present practice puts them, is not of the order that counts for highest efficiency in the metal industries; and that in time there must come improvements in machinery and methods such as will permit these new tools to work regularly and continuously to their utmost capacity. Anything less than this is industrial waste, and cannot be permanent.

SOME PRIMARY CONSIDERATIONS IN THE DESIGNING OF POWER PLANTS.

By A. E. Dixon.

Mr. Dixon's article is introductory to a series which will cover broadly every important phase of the physical and mechanical aspects of the power station. It will be recognized at once as the work of a man who is "on the inside," familiar not merely with plans and projects, but with their practical execution. He deals with the utmost frankness with every question, as it has appeared in his own experience, whether it concerns the architect, the contractor, the engineer, the manufacturer, or the owner.

The September section, which begins the main discussion, will take up the location of the plant, and the storage, handling, and general care of the fuel.—THE EDITORS.

THE generation of power for various purposes is of considerable economic importance, and the field of the power-plant designer is a wide one. There are power plants and power plants, from the rough board shack from which steam or compressed air is distributed to the machinery on a construction job, to the rather ornate structure where the electric power for the operation of the New York Subway is generated, and between these latitudes there is much opportunity for choice. Necessarily, there is a difference between (so-called) temporary and permanent plants; the terms are but relative, for owing to the continual improvements taking place in the machinery for this purpose, it is often a money-saving operation to displace machinery, long before it is worn out, by that which will be more economical in operation. In many cases the units installed for service in plants which are to be removed as soon as the purpose for which they are installed is completed, are as large as and even larger than those used in permanent plants—that is, plants which are permanently located. The main difference between the permanent and the temporary plant lies, usually, in the structure housing it and the conveniences installed. The necessities of the case require a building of sufficient stability only to support, shelter, and protect the machinery and those who operate it, and of a durability sufficient for the purpose to be served.

An ornamental building will not increase the operating efficiency of the machinery, while it will increase the fixed charges; but at the same time it is highly desirable, from an ethical point of view, that the shell encasing a power plant should not be the phenomenally ugly

red-brick excrescence it so often is. To a certain extent it is desirable that the building and its immediate surroundings should present a pleasing appearance, and there is no doubt that such surroundings have a certain effect on the *morale* of the operating force which conduces to the operating efficiency of the plant.

The ultimate and only end of a power plant is to deliver power, in quantities to suit, to the transmission lines, at the lowest attainable gross unit cost, and the building with its contained machinery is but a completed machine for this purpose. The building is erected only for the utilitarian purpose of supporting and protecting the equipment, in such a manner that it may be operated with due economy, and everything must be subordinated to those purposes. The steel frame and the architectural features of the building must be adapted to the mechanical equipment. There are a number of extensive power plants in operation which present evidences of a lack of co-ordination between the engineering, architectural, and structural forces engaged on the work—the *prima facie* evidence being, in some cases, the use of cross or X bracing in places where its use should not be permitted under any circumstances, and more often appearing in an exceedingly ugly, but very necessary, addition to handle the fuel supply and the outgoing refuse. From necessity, most power plants are located on the water front, and to the general public, which rarely sees the plant except from passing boats, the most conspicuous architectural feature of the plant is the corrugated-iron shed over the coal-handling plant. One effect of the blocking up of the fairways with X bracing is an increase in operating expenses, due to the fact that the men cannot get around to advantage, and this may be sufficient to make such misplaced material a most expensive investment; in addition, it adds to the hazard of the operating force in the line of possible death traps should any one be so unfortunate as to be caught in these restricted passages when a pipe breaks. Unfortunately those who are responsible for such conditions do not realize the danger or the extra operating expense due to such structures.

One of the causes leading to such results is the attempt to divide the work on hard and fast lines and to farm it out among several semi-independent departments; necessarily each department is working entirely for its own record, and the resulting assemblage is fearfully and wonderfully made.

The entire work, mechanical, electrical, structural and architectural, is so closely inter-related and overlaps at so many points, that for economic reasons it is absolutely necessary to place all the work,

both in the office and in the field, entirely under one responsible head. Unless this method is followed, a great deal of absolutely unnecessary expense will be incurred; the contractors for different portions of the work, being responsible to different authorities, will be difficult to control; gaps will be found, where contractors do not meet each other, and overlaps, where the same piece of work will be assigned to two or more contractors, the result being more or less confusion and bad feeling between the various departments. This last, while not likely to be openly displayed, will be to an extent a retarding force, holding back the work, often to a troublesome extent, and producing friction between the different contractors. It will be almost impossible to map out the work and conduct it in a harmonious manner, and the responsibility for delays will be difficult to fix, each department endeavoring to pass it on to some of the others.

The contractor first on the ground will preempt all the available space, and later arrivals will find their access to the work so badly blocked that they are put to extra and unconsidered expenses in the handling of their material; this will cause dissatisfaction and make it difficult to secure that mutual accommodation between the several contractors which is essential to rapid progress. The adjustment of difficulties between different contractors will be troublesome, owing to the fact that the departments concerned will endeavor to favor as much as possible the concern handling their particular work.

Another cause of trouble, in many engineering projects, is due to the human frailty that there must be something more than drawings to show at the outset. In spite of the oft-repeated proverb that "haste makes waste," contracts are let from incomplete drawings and on specifications drawn up from them, stating that the privilege of making alterations is reserved and that further detail drawings will be supplied as necessary; unit-price figures are asked for, so that such changes may be made on a fair (?) basis, the portions of the work omitted from the drawing being usually the most difficult and expensive part to execute, and a part which it is impossible to detail until the project has been worked out more fully. For the contractor this sort of a programme may mean a large financial loss and perhaps bankruptcy, for the reason that his only remedy for such jug-handled agreements lies in a suit at law, which puts him to a great deal of expense and makes him wait a long time for a final decision and settlement. On the other side, while the contract costs may look low, by the time all of the law suits are settled and the bills for legal expenses paid, it will be found that such contracts are expensive to handle. In

many cases the contractor will rush the work ahead with the idea of forestalling any changes, and as a result of his speed it will be found that the desired alteration involves the tearing out of completed work; or in many other cases it happens that fabricated materials must be taken over at the contract price, and altered as an "extra," at an additional price, or disposed of at a loss. It rarely pays to make an exceedingly strenuous start on a project of this kind, the time to rush matters being just as soon as all the details are definitely settled and there is no uncertainty in regard to the future of that portion of the work.

The man in charge of the construction of a large power plant must be posted, to a degree, in all the various lines of work involved, and should be permitted to avail himself of the services of competent consulting engineers—specialists in such lines as he may deem desirable—for advice and assistance. In the selection of a consulting engineer for any piece of work, it is of the highest importance that he should be disinterested. It is extremely difficult to serve two masters with strict impartiality; most men's sympathies are with their own pockets, and their judgment is liable to be badly warped by the conflicting elements involved, particularly in those cases in which the consulting engineer happens to be the sponsor of some particular method of dealing with the problem or some of its details, from which method he either directly or indirectly receives a royalty or profits.

All the drawings, particularly those to be used for field construction, should be prepared in one office; nothing should be left to chance; the meeting points of all contracts should be accurately laid out and so clearly shown that no opening for verbal arguments on the question remains. This involves a large amount of detail in many of the lines involved. For the building and foundations, in some portions of the work, regular architectural procedure can be followed—that is, the details can be made to approved drawings submitted by the contractor; but it must be distinctly understood that the approval of drawings does not in any way relieve the contractor from any responsibility in regard to their accuracy. In supplying one contractor with copies of drawings made by another contractor, the contractor supplying the drawings must be held strictly accountable for their accuracy, and this fact should be distinctly stated each and every time such blue prints are sent out.

In other portions of the work it is impracticable to leave the design to the contractor. The entire structure is simply a completed machine, and many portions of the interior must be arranged to exact

dimensions and lines; for this purpose the drawings usually turned out in architectural offices are often worse than useless, unless the proper dream book and trance medium are available for their interpretation. This is due to the fact that a great deal is left to the imagination, and that few architects care to be hampered by exact dimensions.

In the case of large plants it is advisable to insist that the tracings of all approved and detail drawings from which the various machines, equipment, building, etc., are constructed or manufactured, shall become the property of and be delivered to the concern owning the plant. In any case the contractors should be required by the terms of their agreements to supply from five to twenty prints of all approved and detail drawings covering their respective portions of the work. Precautions of this kind may seem excessive, but there are many cases where if attention had been paid to this apparently trivial point the operating company would have been saved a great deal of expense. Many concerns have objections to supplying information of this kind to their customers, forgetting, apparently, that the customer can easily take the machine down and secure all needful measurements to duplicate the drawings, although such procedure is of course expensive. To guard against trouble in the matter it is advisable to provide in the specifications and contract for the delivery of such prints and tracings, and no vouchers should be approved for payment until the appropriate drawings have been delivered. The importance of this provision arises from the fact that many firms have such poor records of their past work that their efforts to supply extra and repair parts are productive of much trouble to those so unfortunate as to have their apparatus in use. In other cases firms fail or go out of business in other ways, and it is difficult, if not impossible, to trace up their drawings after the lapse of years. In a power plant continuity of operation is of the highest importance, and it is a great deal easier and cheaper to look out for such things at the beginning than it will be later on. In many cases the constructing force seems to be pervaded with the idea that a great many things are of small moment, provided they affect the operating conditions only, seemingly forgetting that the future of the plant, which is out of their control, affects in a measure their own future.

In some cases, power-plant projects, and other engineering work, are handled as one contract by a firm of contracting engineers. There are three methods available for letting the work; on a lump-sum price, which is not conducive to the best results; on cost plus a lump sum, or on cost plus a percentage. The former of the last two methods has ad-

vantages when the project is not of sufficient magnitude to justify the organization of a suitable engineering force; the second method likewise has its merits in this regard, but in such cases (except, of course, with contractors of the best standing) there may be some tendency to work in more expensive apparatus than is desirable, in an endeavor to swell the fee received. In case any of these methods is adopted, the best interests of the purchaser will be served by the retaining of an independent consulting engineer, skilled in this line, to advise in regard to the approval of the plans, contracts, and other items. It is to the credit of many of these firms of contracting engineers that they do not handle contracts except on a basis that as nearly as possible renders their interests identical with that of their customers, and while, under the cost-plus-a-fixed-sum contract, the customer has absolute control of affairs, he, unless guided by an absolutely disinterested expert, will be more or less at the mercy of the contractor.

There are a few firms which, besides engaging in the contracting-engineer's capacity, likewise undertake to finance the undertaking, and in many cases also engage in the promotion of enterprises; and there are many projects which, but for the assistance of such many-sided firms, would die in the embryo. The profit to such firms is based on the risk incurred, but as their co-operation often insures the success of undertakings, owing to their being able to supply experienced managers of much greater skill than the enterprise under other conditions could command, in its early stages, there are advantages to be gained by such an alliance, even though it increases the ultimate cost of the installation. High finance, however, rarely results to the advantage of the early stockholders.

There is a time-worn saying, "Look out for the pennies and the pounds will look out for themselves;" for engineering work this can be paraphrased: look out for small details and keep your eye on the large ones.

CHINESE LABOR IN THE LIGHT OF MODERN INDUSTRY.

By Barrett Smith.

The problem of getting sufficient workmen is one which is pressing heavily upon some of the world's greatest engineering undertakings—as for example the mines of the Rand and the Panama Canal—and hopeful eyes have been turned to China to supply the need. It is well worth noting that those who know the Chinese coolie best are generally strongest in his praise. Mr. Smith's testimony is doubly valuable—first because it has been gained personally, in a wide range of work directly connected with engineering industries; and second because it covers not only ordinary labor, but that which in any part of the world would class as skilled.—THE EDITORS.

THE growing importance of China in the trade relations of the world very naturally draws the attention of those interested in the general problem of labor to the Chinese workman, on the score of his fitness to meet the demand of modern industrial conditions. An accurate conception of the problem is impossible, nor may a satisfactory answer be anticipated, save through study of Chinese of the artisan and coolie classes at work in China. The variety of race and the variety of caste found in the large industrial establishments in the Empire could certainly not be duplicated anywhere outside. The racial variation is always at first a surprising feature, and the dissimiliarity of physique and of temperament between the representatives from the two great halves of China roughly divided by the Yang-tse River is very marked, especially near the coast.

Whatever the use made of them, the opportunities for sizing up the Chinese workmen in their own country are certainly ample, for there are now in the coast provinces many large engineering works and general industrial establishments dependent for successful operation, always in part and often indeed wholly, upon Chinese operatives. Further, Chinese management of enterprises, essentiallly foreign in character, is not the least uncommon. It is thus evident that even a brief connection with engineering or manufacturing developments there, must afford considerable, if not ample, grounds for study of the question of Chinese labor.

I was occupied in China for more than a year on work connected with a large industrial establishment in which were employed native

workmen, including stokers, enginemen, electricians, fitters, machinists, masons, carpenters, and coolies. Of this staff I had direct supervision and consequently was thrown in daily contact with the men and their work. A large percentage of the craftsmen were trained in the great ship and engine building shops of Farnham Boyd & Co., in Shanghai, a schooling comparable to that afforded by similar organizations in England and America. Therefore, a sound basis was gained for the general comparison of the performance of Chinese skilled labor with that of occidental countries.

The average foreigner compelled for the first time to struggle with the labor problem in China will, after a brief experience, be possessed of some two or three remarkably distinct impressions in the general confusion of ideas. If it constitutes his introduction to the Chinese people, he will probably be struck first by the differences between individuals. Whereas he has pictured the Chinese as cast all pretty much to the same mould, he will find that they display quite as much individuality as Western peoples. Secondly, he will descry, usually only under some especial stress, however, evidence of surprising cleverness, not only at imitation, but at creation. Finally, he will come to the conclusion (if he is not forced to it) that these beings whom he had thought of before almost as creatures apart, are after all surprisingly human.

Naturally pre-eminent among the skilled craftsmen of China, the carpenter still maintains the leadership. Though almost invariably wedded to the use of the tools of his ancestors and to their methods, judged by results he is more efficient in his line than are the average of the foreign trained fitters and machinists in theirs, though a constant diminution of the difference is in progress.

In judging the performance of the native workmen, it is almost impossible to avoid the popular bias that addiction to their own methods and tools invariably bespeaks fatuous conservatism. Though this is in many cases true, it will often be found on careful observation that what has passed for a stubborn blindness to the virtue of innovation, is in reality a keener perception of comparative merits than the judge himself was aware. This is particularly true of Chinese carpenters. While most of their commonest tools differ in some radical way from our own, it is never safe to assume the superiority of the Western product. Their small ax for example, is a beautifully balanced tool, and they are remarkably adept in the use of it, being able to work as true a surface therewith as can be obtained with an

adze in the hands of the white man. On heavy work it is customary for two to hew together on opposite sides, striking alternate blows. Both hands are used and the recover is over the shoulder, alternate right and left. There is a freedom of swing with an accuracy of delivery that is a treat to watch, and the rapidity of blows is almost bewildering.

With the introduction of the nail into his craft, the Chinese carpenter was in need of a hammer. His ax is provided with a sort of hammer face, so he came to use that. Though a good ax, the tool is a bad hammer. However, a large proportion of the hammers first introduced from the West by importers were poor imitations of what a hammer should be, and the Chinaman rightly judged it no better than his own, so generally repudiated it. Here was another evidence of so called obduracy. At a venture, I secured a small consignment of thoroughly good claw hammers for trial with my own men. Shortly thereafter a man chanced to lose his ax-hammer at a juncture where it was very badly needed in the latter function. I presented him with one of the new lot. He "hefted" it and swung it with a grin of dawning satisfaction. When I made the next round he was wielding the new acquisition with energy.

In the course of a few days there occurred again the loss of a native tool, which resulted in the presentation of another of my hammers. At the third occurrence of the phenomenon my suspicions were slightly aroused. Upon the fourth, I decided it was time to begin an investigation. These hammers seemed the source of a rare satisfaction.

It was arranged to begin prematurely, a phase of the job in hand which required a great deal of ax work. After giving directions, I retired to watch developments. There was a rather ostentatious struggle to meet the demand of the work with a short supply of axes. Then the boss-carpenter made a plea for a new supply, which was refused; moreover, he was told that as some of the men seemed to be loafing, it might be just as well to reduce the force. Alarmed at this possibility of a reduction in his own "squeeze" he took another course. One by one, when my back was turned, the lost axes were unearthed. Judicious intervals were interposed between the respective recoveries but that was merely "face pidgin." They knew that I was in no way deceived, but so long as I had no actual proof, their "faces were saved." They were all immensely pleased when they were permitted to keep the new hammers. The remainder of the

force was likewise equipped, and thereafter the work progressed smoothly and satisfactorily.

The boss-carpenter referred to in this connection was both the finest workman and the best executive among the native artisans in the establishment where I was engaged while in China. More than that, he was instinctively a gentleman and the part he played in the above outlined episode could not be held reprehensible by anyone at all familiar with the Chinese ethical code. To me his virtues quite transcended the stigma of that petty artifice. But this is a digression.

There was undertaken in the plant of the organization, the design and installation of a cooling-tower condensing system. The cooling tower was constructed complete from timber in the rough, only the pumps, fans, etc., being brought out from home. This was the first plant for the continuous use of condensing water installed in North China, and to the best of my knowledge the second or third in the Empire, so that it was a complete novelty to our workmen.

It may be well imagined, then, how much of its ultimate success was dependent on the receptiveness of the Chinese mind. The mainstay in the execution of this important work was the boss-carpenter, who quickly absorbed, not only the proposed structural features, but the utility of the cooling tower. It must be confessed that he arrogated to himself the functions of construction superintendent, and bossed carpenters, masons, and fitters alike, with a surprising absence of friction. Even design was not beyond him, and he evolved and submitted a very clever device for the compensation of expansion of the timber in the tower, under the influence of moisture, which was adopted and worked ideally. Certainly this case was an exceptional one, but it amply demonstrated that in the Chinese working classes there are men without foreign training who are fully capable of taking active leadership in the industrial regeneration of China.

This man was a Northerner, a Manchu, of a race generally believed to be less astute and less energetic than the Southern Chinese. In the present state of industrial development this would appar to be so, and it is a curious contradiction of the usual relationship between people of temperate and tropical or semi-tropical climates. Its exceptional nature raises a very reasonable doubt of the permanency of the ascendency of the Southern Chinese in trade and industry. They do, however, display a consistency of energy unusual in inhabitants even of semi-tropical countries, and for this reason may continue their domination of the Empire.

The commercial superiority of the men from south of the Yang-tse River is practically duplicated in the trades. So strong is the tradition, that no Southerner beginning business for himself in the North, whether he be shipwright, foundryman, or cobbler, would fail to include in his shingle a statement of his native habitat, and there is a deal of genuine provincial *esprit-de-corps.*

As might be expected, this sectional feeling is sometimes accounted a source of trouble where both Northerners and Southerners are engaged on the same work, but I suffered so little personally in this respect that I should always be inclined to look further for the seat of difficulty.

Considerate treatment is undoubtedly an important factor, and many plant managers court disaster by brutal treatment of workmen. In this case considerate treatment is not meant to imply kindness in any decided degree, but principally justice. The Chinaman is keenly appreciative of the "square deal" in everyday life, but he is nevertheless quick to take advantage, like all Orientals, of any display of sentiment on the part of a superior. While manifest kindness is unsafe, a great many, far too many, plant managers, construction superintendents, and others having supervision over native labor, err on the side not of severity merely but of brutality. A large percentage of the superintending engineers on the China coast are ex-ship's-engineers who have naturally gravitated from employment in the coastwise trade, which is large, into land practice where the demand has at times been considerable. On shipboard it is customary to rule with an iron hand in the engine-room as well as on deck, and confined as he is, the Chinese hand has no alternative but to obey promptly if he would escape violent treatment. Ashore these tactics of superior might are obviously poor policy, but accustomed to the maritime practice as he is, the psuedo-superintending engineer very often fails to weigh the consequences of their use, even after much direful experience. In extenuation it must be said that the Chinese workman with his methods, especially if he be a bit raw, is beyond proper management the moment the least irritability is manifested. A creature of vast patience himself, a show of impatience on the part of one supposedly his superior nearly always appeals to his sense of humor, and if the show of temper be very pronounced it will likely elicit also his amused contempt. When this stage is reached a dead-lock generally ensues and forcing only magnifies its duration. It is best then for the "foreign man" to retire from the

scene of action and allow matters to take their natural course for awhile. The natural impulse is to go to the other extreme and resort to force. In such case the spirit of passive resistance on the part of the celestial is quickly transformed into a genuine Occidental strike mood and he arises and departs with all his brethren. A strike due thus to wounded sensibilities is always a more serious matter than a strike over wages or the like, because his dignity, or his "face" as he calls it, is absolutely the Chinaman's valued possession. It is almost impossible to persuade workmen so offended to return on any terms, and the unfortunate manager must gather a new force as best he may—not always an easy task to accomplish on short notice, especially if it be a case of skilled labor.

In the plant where I was engaged during the most of my stay in China there was little or no serious friction of the above sort, this freedom being due undoubtedly to more causes than one. First, it was an unwritten rule never to use the slightest semblence of force except in cases of palpable insubordination. In many other establishments in the neighborhood employing numbers of natives, incompetence was not sufficiently differentiated from insubordination in its reception—a very great mistake. While we were, on several occasions, compelled to resort to physical force in cases of obstreperous spirits bent on mischief, the justice of such action was never once questioned by other workmen, though they were often members of the same guild, bound by ties not unlike those binding the members of our own labor unions together. It was partially the thought of this fact that called forth the previous remark regarding the Chinese appreciation of justice.

Another factor or rather condition tending I believe to render us immune from labor difficulties was the racial division always carefully preserved in our force. Half northerners or Manchus and half southerners, Shanghai or Ningpo men, was the rule, simple in itself but certainly rather bizarre in its working. Whereas one would be apt to expect endless trouble from sectional jealousy, the sectional or provincial *esprit-de-corps* being so very strong, there resulted only a healthy competition between the factions. Immediate personal contact, and therefrom the opportunity to disagree and make trouble, were prevented by the arrangement of the various gangs according to race, each gang being made always homogeneous. Whenever it was necessary to employ men from both factions on the same piece of work, the supervision of a white man was invariably a part of the programme.

The strength of the provincial fellowship as contrasted with the lack of national spirit in the Chinese is a source of constant speculation to any thoughtful foreigner dealing with the Chinese. It seems almost inevitable that with the supply of an ample system of railways and telegraph lines in China, this provincial sentiment of kinship must ultimately be transformed into a national patriotism as strong and enduring as any the history of the world records today. But the interval is a vast one and will demand much bridging. For example, a Cantonese of the middle class at the present time looks upon the far Northerner, even after considerable personal acquaintance, as a being of racial attributes distinctly foreign to his own.

Returning to the topic of the distinctive proficiencies in the various crafts a great deal might be said. Fitters and machinists have been given the reputation very often of inaccuracy, but personally I have never seen one, thoroughly trained to an understanding of the necessity for accuracy, who was not quite as reliable in that respect as the average Western workman and I have seen some convincing examples of native ability to turn out big work where accuracy was by all means the prime consideration. One instance in point was a job of sheathing with gun metal a large hydraulic ram 30 inches in diameter and several feet long. The sheath was separately cast and machined to fit, and so accurate was the machining that it was slipped on with less than 1,000-pounds pressure, the pressure *apparently* bearing a simple and smooth relation to the travel of the sheath over the iron core. On other occasions too I have quite marvelled at the delicacy of touch of the Chinese machinist while calipering. This sheath itself by the way bore testimony of a native foundryman's proficiency. It was very nearly as hard as I have ever seen even in a small casting, and was at the same time practically flawless when finished, though it was turned to a thickness of only 5/8 inch. This entire work, including founding and machining, was executed absolutely without the participation of any foreigner, in the works of the Chinese Engineering & Mining Company at Tongshan, near Tientsin in the province of Chili.

Even so superficial a treatment of the broad subject as the present must include a word regarding wages and hours. The standard of wages for men is the equivalent of 25 cents per day, United States currency, for all skilled labor, and 12½ cents for unskilled. The question of hours is a more variable quantity. When working for himself or for a native employer, every minute of daylight is utilized,

only the deliberate working pace permitting the maintenance of such long hours. When working for a foreign employer, the standard working day is generally ten hours, though exceptions to this rule occur sometimes when the employer is blessed with conscientious native foremen who will maintain the long hours themselves and keep the rank and file up to the scratch adso. In the observation of Sunday as a day of rest there is great diversity of practice. In the centers of modern industry such as Shanghai the observance of Sunday as a rest day has become the rule, but in more isolated regions where the foreign influence is not strongly felt, only the occasional Chinese holidays are observed, culminating in a solid three-weeks' shut down at the Chinese New Year season.

In times of special stress, speaking of the maintenance of work, the Chinese ability to labor constantly with scanty rest is remarkably demonstrated. In one instance that recurs to me we had a bad engine smash-up centering about a broken connecting-rod. The attendant calamities were numerous and nerve-trying. It required an even forty-eight-hours work on the part of the whole engine-room staff to clean up the situation, and the average of respite for sleep and refreshment during that time was less than three hours. The boss-blacksmith, upon whom the bulk of the work devolved, was constantly afoot during the whole of the time. Possibly most remarkable of all, there were but two or three inconsequential expressions of complaint heard in all the force.

Experiences of the kind cited in this brief review certainly justify a fair measure of optimism in estimating the future of the Chinese, as they are now being tried and will further be tried in an ever increasing variety of modern industrial vocations as the material welfare of the Empire advances.

EDITORIAL COMMENT

IN considering the possible traffic through the Panama canal it may be of interest to examine the manner in which the business of the Suez canal has developed, and the manner in which it has been found necessary to increase the capacity of that waterway.

Thus, in 1875, there passed through the Suez canal 1,494 vessels with a total capacity of 2,000,000 tons, and in ten years' time the traffic had increased to 3,624 vessels and more than 6,000,000 tons. Then the influence of the increase in the size of vessels appears, for by 1895, ten years later, the number of ships had actually diminished, being 3,434, while the total tonnage had increased to nearly 8,500,000. The report for 1904 shows the passage of 4,237 vessels, with a total of 13,400,000 tons, of which three-fifths was represented by British vessels, and the traffic for 1905 is placed at 19,000,000 tons. The receipts of the canal from tolls grew from 26,000,000 francs in 1875 to 76,000,000 in 1895, and to 113,000,000 in 1904.

The traffic through the canal, indeed, furnishes a sort of comprehensive view of the commercial development of the world. England, as noted above, has steadily maintained her three-fifths of the total; Germany has trebled her tonnage in ten years, while France has barely doubled in the same period, losing her former post of second in rank. Japan, from a beginning of two ships, 2,350 tons, in 1895, rose in 1903 to fifty-three vessels of a total tonnage of 220,966. The United States is negligible; its figures are so small as to be merged in the "miscellaneous".

In order to meet the increase in traffic there has been an almost continual effort to develop the capacity of the waterway. The depth in 1883 was 8 metres, with a width of 22 metres. At the present time the depth of 9 metres has been effected for nearly the entire length, while the minimum width is now 37 metres, and the minimum width on curves has been increased to 52 metres. Before the introduction of the electric-lighting system, making it possible to continue navigation after nightfall, the duration of the traverse was about forty-eight hours, while the increase in dimensions of the canal prism, and the ability to proceed by night as well as by day has reduced the time to an average of eighteen hours.

The grounding of vessels formed a serious matter in the early operation of the canal, but at the present time the groundings have been reduced to 15 per cent of the total number of passages, and but 3 per cent if we include only those ships which are unable to release themselves and must be aided by the special appliances of the Company.

At first the charge for passage was 10 francs per ton, but with the increase in traffic this has been reduced so that it now stands at 7.25 francs per ton, upon the registered tonnage of the vessel, whether fully loaded or not.

An important fact, bearing upon the work now being conducted at Panama, appears in the greatly improved sanitation of the Isthmus of Suez since it has been under the control of the canal Company, malarial fevers, formerly prevalent, having been very greatly reduced by the efforts of the Company.

It is to such developments that the Panama commission may look for encouragement and guidance, and although there is no such immediate source of traffic for Panama as existed in the case of the British commerce with India via Suez, there is every reason to believe that the established law that

"facilities create traffic" will operate at the one isthmus as it has at the other.

* * *

One of the pressing problems of the day in all great cities is that of the relief of the congestion of the streets in the business and commercial quarters —a problem which is daily becoming more and more complicated with the introduction of motor vehicles, and with the erection of crowded tall buildings. The introduction of various methods of rapid transit, whether by the use of elevated railways, subways, or extended surface traction, continually tends to increase the congestion on the sidewalks and at the crossings, making traffic more and more difficult, and increasing the very troubles the improvements were intended to relieve.

The real difficulty at present appears to be the foot passenger, and doubtless if it were not for him the traffic upon the streets could be accelerated many times, both by permitting rapid and unimpeded speed on the part of vehicles, whether horse-drawn or mechanically propelled, and by allowing free access from delivery teams to and from buildings, regardless of the obstruction of the sidewalks.

If, then, the congestion in business streets is to be relieved the foot passenger must go. But whither can he be sent? Some have taken hint from the present disposition to put everything underground, and insisted that subterranean footways, possibly accelerated in capacity by the addition of traveling sidewalks, are the only method of relief. For brief periods this may do, but not as a complete solution of the whole question. Fortunately there is another solution, one which, from its numerous advantages, should appeal to all elements in the community. Instead of placing the sidewalks below the surface they should be placed above, on a line with the second-floor level of the buildings, forming a second street level, so far as the foot-ways are concerned, and leaving the middle of the street clear. This plan should provide an elevated structure on each side of the street, light in construction, being strictly reserved for foot passengers, giving access to all the shops and buildings along the route, and thus doubling their entrance capacity, while at the same time leaving the street level below entirely clear for vehicular traffic. All cross streets should be spanned at the second-floor level, so that no grade crossings need be made, and with such a provision for the foot passenger, he should be permitted on the surface level only at his own risk.

* * *

Architecturally, this plan for a double-decked city has much to recommend it. In many places the idea of strect arcades has been employed for no other reason than to obtain the effect which is produced to the eye, and the colonnades of the Rue de Rivoli in Paris, the arcaded streets of the old city of Bologna, and the "rows" of Chester may be cited as examples. In more modern times the examples of the "board-walks" of many of the seaside resorts give some idea of the manner in which the most crowded streets of the most densely populated cities might be rendered free from discomfort, while at the same time the access to the buildings would be doubled and the streets left clear for high-speed automobiles and electric railways. Instead of placing the heavy and noisy electric railways upon an elevated structure, itself necessarily unsightly and expensive, the proposed plan would give the solid ground to the heavy traffic and lift the lighter load to the higher level in a manner which would permit an artistic incorporation with the design of the buildings by the way, adding greatly to their value and accessibility, instead of placing a hideous and noisy structure under their windows.

An important consideration which appears in connection with the idea of elevated sidewalks for foot passengers is the fact that it may be put into operation gradually, and portions may become available immediately, without waiting for the completion of the entire structure. In the more crowded business districts such elevated sidewalks might be erected without delay, descending to the surface level as the less congested portions were reached, the elevated walk being continued as building improvements and business activity progressed. In this respect, as in many others, the elevated plan has a vast superiority over any subway scheme, the latter including the completion of the greater portion of the work before any of it could be thrown into service. In any case it is most important that the great bulk of the public should be given place in the outer air, above the dust of the street, and freed from the surface accumulation. The elevated sidewalk could gather but a trifling amount of dirt, as compared with the possibilities of the surface street, with its sweepings and animal droppings; and if, as might well be considered, the elevated structure were made of reinforced concrete, it might readily be washed clean from all refuse at small expenditure of labor and time.

* * *

Both pedestrians and vehicle owners should perceive that it is useless to enter into conflict as to their respective rights upon the streets. Both methods of locomotion are essential, and neither should be permitted to interfere with the other. In the automobile we have one of the most potent appliances for the development of civilization which can well be conceived, and any attempts to restrict its capabilities must be considered as altogether undesirable, ill-advised, and futile. This being admitted, it remains to permit full freedom of development to the mechanically-propelled vehicle, and at the same time give increased freedom, convenience, and satisfaction to the pedestrian, himself in many cases also included among the owners and users of the automobile.

Conceding the right of each class of the community to do as he pleases without interfering with the right of the other to do as he pleases, we have a solution of the problem in the elevated sidewalk and the open and unimpeded surface street—a solution which should appeal alike to rider, driver, pedestrian, merchant, and architect, giving increased opportunities to all, while detracting from none, and adding to the value of the city for every dweller and visitor.

* * *

If, as we have heretofore deplored in these pages, we have been lamentably slow as a Nation to free alcohol from taxation so far as to enable its use in the arts, and especially as a fuel, we are at last promised a vigorous awakening. The Department of Agriculture has promptly recognized the conditions opened by the recent passage of the Free Alcohol Bill, by arrangements for the issue of a special bulletin, to appear January 1, 1907, thus giving to the public, at the very moment the new law goes into effect, the fullest and best collection of data obtainable concerning the use of alcohol in small engines. The bulletin will contain all the work done in this field, both here and abroad, together with a complete bibliography of the literature of the subject, and a record of the results of experiments and the conclusions to be drawn therefrom as to American practice and opportunity.

Dr. Charles E. Lucke, whose striking investigations of the gas turbine form the topic of the leading article in this number, has been retained as the expert in charge of the study and experiment, and the work will be carried on in the laboratories of Columbia Univer-

sity. Its scope is so extensive that Dr. Lucke is most anxious to secure the freest possible co-operation of everybody interested. He will cordially welcome data, or information as to the location of data which may be uncovered by further search. Owners of patents are invited to communicate with him, and any who way have vaporizers, carburettors, or complete engines are earnestly requested to submit the devices for test in Dr. Lucke's laboratory. The tests will be carried ont without any expense whatever to the public, except the bare cost of transportation, and the results will be published in the bulletin.

Due acknowledgment will be made of all assistance given, and all apparatus and materials will be retnrned when the work is completed. Correspondence and shipments should be addressed to Prof. Charles E. Lucke, Columbia University, New York City.

A large measure of the value of the new legislation depends upon the promptness and energy with which engineers and manufacturers attack the problems and avail themselves of the opportunities. The Government in this instance has certainly shown admirable, not to say unusual, readiness of initiative. It is greatly to be hoped that the response from individual inventors, investigators, and manufactnrers will be correspondingly active and energetic. Certainly the policy from which all have most to gain now is that of full publicity and co-operation. Competition and rivalry should be confined, for the present, to seeing who can offer most for the public information and education.

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The Annual Statistical Report of the American Iron and Steel Association for 1905, presented to the members on June 30, contains an almost bewildering picture of the enormous industrial activity of the year covered by its data. We could wish, perhaps, that the Association would supply a ready key to the vast field upon which its figures are assembled, by furnishing an index. The table of contents is only a general guide, leaving the searcher for some special fact under the necessity of making his own detailed exploration of the section into which the table directs him.

The huge fact which dominates the whole report is the increase—"simply marvelous," indeed, as the report styles it—in the production of iron and steel in the United States, as compared with 1904. Pig iron jumped from 16,497,033 tons to 22,992,380 tons, and steel from 13,859,887 tons to 20,023,947 tons. Rails alone rose from 2,284,711 tons in 1904 to 3,375,929 tons in 1905; but as the increase of new mileage on steam roads was about the same during the latter year as during the former, the extra consumption appears to have gone into electric lines or the relaying of old track with heavier steel. In contrast with former experiences during the boom times in the industries of the country, it is very noteworthy that prices advanced but little. Rails, of course, were kept at the uniform price of $28.00 which has been maintained by the mills since 1902. Bessemer pig at Pittsburgh rose from an average of $13.76 in 1904 to $16.36, average, in 1905, and steel billets from $22.18 to $24,03. As compared with the prices of $20.67 for Bessemer pig and $30.57 for billets which ruled in the average at Pittsburgh during the prosperous times of 1902, the figures for the last year look modest indeed.

Another interesting point is the sudden up-curve in the production of Bessemer steel, which up to the year 1905 had been steadily declining from its former maximum of 9,138,363 tons in 1902. In 1904 the output was but 7,859,140 tons; all the increase seemed to be going to the open-hearth process. In 1905, however, while open-hearth steel rose from the 5,908,166 tons of the

preceding year to 8,971,376 tons, Bessemer leaped past it to a total of 10,941,365 tons.

Even the steady gain of the basic over the acid process in the manufacture of open-hearth steel, which has been so noticeable during the years since 1896, suffered a check and appears as a fraction of one per cent only. These phenomena seem to indicate the return to the active use of obsolescent plant under the stimulus of unusual demand.

The production of iron and steel in the United States alone in 1905 exceeded the output of the whole world in 1887. In marked contrast with Great Britain, it was manufactured wholly from domestic ores, and consumed almost wholly in domestic manufactures. In view of the enormous increase in the rate per capita, we might well recur to the question propounded by J. Stephen Jeans, writing in this Magazine some years ago—how long can it last? And closer than that stands the problem more recently proposed by James J. Hill: what of the time, perhaps not far distant, when our exploitation of natural resources outstrips the development of the country and its internal demand? Sooner than we expect, perhaps, we may find ourselves in need of those now lightly esteemed markets of the world.

We may find the wresting of foreign trade from well intrenched European rivals a more serious task than the protection of home markets against their entry. Prudence demands at least that we take stock of our equipment and our tactical position in case the battle should change front. There are some who hint that we are falsely secure even in the matter of our mechanical pre-eminence—that we are slowly being enslaved by over-indulgence in systems and standards, excellent within bounds, but tending to ossification and atrophy. In our September issue we shall present a striking and thoughtful article by Dr. Louis Bell—a plain-speaking, fearless search into the truth of the American position and system, which we believe will open the eyes of many of our industrial leaders to the fact that times are changing, and we must change with them.

We believe Dr. Bell's arraignment and exhortation will be the starting point of a wide-spreading movement for the reawakening of the mechanical industries of the country, and we commend it most earnestly to all our readers who are justly proud of the progress the Nation has made in material civilization, and jealous for the maintenance of our lead in the things which belong to the province of engineering and mechanical industry.

* * *

In the death of Charles Paine last month, the engineering profession lost a leader of rare type—a man in whom professional ability, literary talent, and æsthetic perception were all co-ordinate and all highly developed, but who impressed most of all by his broad humanity. His friends loved him for what he was as much as they respected and admired him for what he did in the direction of large affairs. It was good to see how the faces of his associates would kindle with pleasure at the mention of his name.

It *was*—rather let is say it *is*, and will continue to be. He is not one whose memory will die out of the hearts of those who knew him.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

MUNICIPAL OWNERSHIP OF ENGINEERING UTILITIES.

THE ORIGIN, MEANING, AND PROPER TREATMENT OF THE AGITATION FOR MUNICIPAL OWNERSHIP IN THE UNITED STATES.

Everett W. Burdett—National Electric Light Association.

IN view of the present spirit of unrest and discontent regarding the operation of public utilities in the United States, leading to the agitation for municipal ownership of enterprises hitherto mostly conducted by associations of private capital, the thoughtful address delivered before the National Electric Light Association by Mr. Everett W. Burdett demands attention.

Mr. Burdett admits that there has been good reason for adverse criticism, and refers to the manner in which, in certain instances, there has been just objection to the manner in which corporate organizations have abused the confidence which has been placed in them. This, however, is but one side of the question, and the other side should be given fair consideration, before the advisability of transferring the control of public utilities to municipal control should be conceded.

"Forgetting the beneficent results which have been obtained only through the accumulation of great wealth derived from corporate organizations, the dissatisfied citizen sees only the abuses of financial and corporate power of which he has been, or imagines himself to be, the victim. The very word 'corporation' has come to have an opprobrium of its own.

"And yet, of course, this wholesale distrust and condemnation of wealth and corporate power is unreasonable. It loses sight of the fact that we are unable to assert from what other source the people at large would have derived the blessings which have come from the establishment and maintenance of the almost countless hospitals, libraries, colleges, parks, museums and special funds for the encouragement of learning, the promotion of science, the reward of courage and endeavor, and the various other beneficent uses for which they have been established and maintained by private wealth, largely derived from corporations. They forget that it has been only by the uniting of the funds of the rich and the savings of the poor in corporate organizations that the country has been developed by the establishment and exploitation of numberless forms of industrial enterprises, which have given employment to labor, activity and volume to trade, and a market for all the products of our soil and all the talents of our people.

"In electrical enterprises the central station electric lighting investment in the United States alone already aggregates 700 million dollars, involving an annual operating expense of nearly or quite 100 millions, distributed among all classes of workmen and through every artery of trade. The census reports show that in the single year 1904 there was an output of new electrical apparatus of the value of more than 150 millions. There are nearly 5,000 central electric lighting stations. There are 23,000 miles of electric railway, carrying each year over 5,000 million passengers. A network of nearly 300,000 miles of steam railroad gridirons the country, transporting upward of 750 million passengers annually. Spoken words are transmitted through more than five million miles of wire, by

the use of more than three million telephones, by which more than 5,000 million messages are transmitted yearly.

"All these wonders we owe to corporations. They have given free play to the enterprise and individual energy of our people, and have made that enterprise and energy vastly more powerful and effective than it otherwise could possibly have been. They have enabled the man of small means to do a part of the world's work by joining his savings with the capital of his wealthier neighbor. They have encouraged thrift and the spirit of investment. They have advanced civilization and brought to every man's door the diversified products of our own and other countries."

Mr. Burdett calls attention to the fact that the principal beneficiaries of the development of corporate organizations have been, not the organizers, managers, and stockholders of these enterprises, but the general public, and that the community at large has obtained vastly greater benefits from corporate enterprise than have those whose money has made them possible. A comparison of dividends paid with services rendered shows the truth of this statement, and demonstrates that the tax-gatherer, the employé, and the general public have each and all reaped rewards vastly greater than have been realized by the stockholders in the enterprises. The existing widespread agitation for the municipal ownership and operation of public utilities may really be attributed to the influence upon the popular mind of the widespread dissatisfaction and resentment occasioned by the abuses of great wealth and corporate facilities. To this must be added the skilful use of this dissatisfaction by politicians, seeking to turn public opinion to the advancement of their own ends.

"In pointing out the fallacy of adopting municipal ownership in the United States on the strength of its alleged successes abroad, the first thing which is to be suggested is the danger which always lies in the offhand adoption of foreign methods, laws or practices in another country. It can seldom be done successfully. Differences in political, economic or social conditions almost always exist which render the transplanting of the customs or methods of one country into another inexpedient.

"As contrasted with American municipal service, that abroad is less political and more business-like in its character, more certain in its tenure, more continuous in its service and more disinterested in its activities. Its desirable features are not only secured and protected by law, but are demanded by public sentiment. While the raw material is perhaps as good or better in the United States than in the European cities, it is handicapped in its efficiency by its political character and the uncertainty of its tenure. The American municipal servant never knows how long he is to be permitted to hold his place and is subject to constant changes in policy and supervision. The only thing he can be reasonably sure of is that his head will ultimately drop into the basket. This system, for system it has come to be, may perhaps prevent dry rot and some of the evils of bureaucracy, but it is at the expense of efficient public service."

An examination of the operation of municipal ownership in Great Britain does not give positive assurance as to the success or failure of the system in the United Kingdom. In some instances, in electric lighting, for example, a little more than one-half of the municipal undertakings have showed a profit, while a much larger proportion of private enterprises have been found profitable. It is not by financial returns alone, however, that a system is to be judged. A well managed system shows its efficiency by the extent and nature of its development, by the completeness of the public service rendered, and by the real additions to the wealth of the community which are effected by its operation. Judged by this standard the operation of such utilities as electric lighting, telephone service, electric power distribution, and the like, by municipalities, cannot compare in efficiency with the work of private corporations. In support of this view Mr. Burdett refers to the action of the Institute of Electrical Engineers to endeavor to overcome the restrictive action of local authorities upon the development of the electrical industries in Great Britain.

"The remedy for existing conditions must come from both within and without. The companies interested, the public authorities and the public at large must each

contribute to the solution of the problem. None of them can or will be wholly effective without the others. Human nature is such that it can not be trusted to regenerate itself, public clamor is frequently ineffective, while enactments of the legislature can not accomplish all that is desired.

"In the first place, the companies engaged in furnishing public services must, in their own interests, strive more and more to give good service at fair rates. While they can not all avail themselves of the advantages of the legal so-called sliding scales, they can hope for the best results only along the line of the theory of the sliding scale. In my judgment, the time has gone by, if it ever was, when extortionate rates and wretched service will promote the interests of the corporations. He who serves the public best serves his company best. Patience and a spirit of conciliation, and a real desire to increase facilities and reduce charges as rapidly as consistent with such management, will ultimately bring their rewards in the form of increased earnings and larger dividends. And when the public, in any given community, comes to see that, notwithstanding the mouthings of the demagogue and the agitator, it is being fairly treated by the corporations, its objections to large and increasing returns upon invested capital will gradually disappear.

"Next: the abuses of great wealth and corporate privileges to which I have alluded must cease, or at least be greatly mitigated. Self-interest must realize the fatality of a continuance of the abuses involved in gross over-capitalization, poor service, high-prices, discrimination among consumers and above all the attempt to control the law-making power for purely selfish ends.

"Third: Public sentiment must be cultivated. The one great need in the economic world, is popular education along sound economic lines. Let us no longer leave the exploitations of vital economic principles to the visionary or the doctrinaire, on the other hand, or to the irresponsible politician or selfish agitator, on the other. A real campaign of education is what is needed, a broad, comprehensive, intelligent, persistent, aggressive and well-directed campaign, which shall leave nothing in reason undone to spread sound economic doctrines. So far as self-interests enter into it, let it be an enlightened self-interest, having in mind the rights of all; let it be devoted to the fundamental proposition that all members of the community are bound together in such intimacy of relation that no member can ruthlessly injure another without ultimately feeling the recoil upon himself. 'Live and let live,' should be the motto."

POWER GAS FROM LIGNITE FUEL.

PRACTICAL EXPERIENCE IN THE GENERATION OF FUEL GAS FOR COMBUSTION MOTORS FROM THE BROWN COALS OF GERMANY.

H. Neumann—Verein Deutscher Ingenieure.

WITH the development of the internal combustion motor there has come a corresponding interest in the provision of a cheap and satisfactory fuel for such machines. We have seen how the agitation for a suitable and abundant liquid fuel for such motors has resulted in the liberation of alcohol from an onerous and unnecessary tax in the United States as in other countries, but there are fuels available which have not been sufficiently developed, and for which the combustion motor is especially well adapted, and among these we must include those partially carbonised fossil fuels, indifferently known as brown coal, lignite, peat, and the like. The prevalence of such fuels in Germany has led to an examination of their availability for the generation of fuel gas, and in a paper recently presented before the *Verein Deutscher Ingenieure* by Herr H. Neumann this subject is given careful discussion, including practical details of gas producers, scrubbers, etc.

Lignite, or brown coal, forms a very important portion of the natural fuel deposits of Germany, coming close behind bituminous coal, the present yearly output of lignite reaching 48 million metric tons, of which 38 million tons are produced in

Prussia and the balance in the rest of the Empire. There are also large deposits in Bohemia, and in other parts of Europe. A portion of this fuel supply has been available by briquetting, and it is estimated that about ten million tons are thus prepared in Prussia alone. This method is not always available, however, and any way in which lignite may be efficiently used as a power fuel is certain to be welcomed as of great economic importance, both to Germany and to the rest of the world.

The employment of the gas producer as a means of preparing fuel for the internal combustion engine has, until recently, been assumed to be limited to work in which either anthracite coal or coke was available as fuel. With bituminous coals the action of the producer is found to be irregular and uncertain, involving much barring and poking to prevent caking and obstruction, while the production of tar and other impurities has rendered the gas unsatisfactory.

The high price of anthracite, however, has led to persistence on the part of designers of gas producers and appliances to adapt the apparatus to the use of cheaper fuels, and it now appears as if the whole field of power-gas machinery has been opened to the use of the cheap and plentiful brown coal, hitherto of but limited utility.

In Germany the lignites appear in various forms and constitutions, some deposits furnishing large blocks, others masses of distinct woody structure, others again in lumps of earthy nature. A tabular view given by Herr Neumann shows that the German lignites contain from 40 to 80 per cent of combustible, with 60 to 80 per cent of moisture and ash, the non-combustible solid being generally in a small proportion, rarely more than 5 per cent. The calorific value of these brown coals ranges from 2,000 to 5,600 calories per kilogramme, corresponding to 3,600 to 10,000 B. T. U. per pound. The large proportion of water contained in some of the lignites renders it desirable that they be partially dried and compressed into briquettes before transportation, from 15 to 17 per cent of moisture being retained in the compressed blocks.

Such a fuel, when gasified according to the ordinary processes, produces a number of auxiliary products of distillation, such as paraffine, tar, creasote, etc., these passing, in a volatilised condition, out with the gas. Although these by-products may have a technical value, they are undesirable in connection with the generation of power gas, and when separated are so diluted with water as to render their utilisation a matter of too great cost to render them of commercial value.

Two methods may be adopted in dealing with such products in the generation of fuel gas; the lignite may be gasified in the ordinary manner, and the gas then passed through various purifying devices to remove the volatile elements; or the producer may be so designed as to convert the tarry products into fixed gases, forming a portion of the gaseous product. The former method permits the use of almost any type of generator, while for the latter process a specially designed producer is necessary.

In the earlier gas producers for use with lignites, the principal effort made was to provide for the removal of the slag and cinder, such methods as the provision of an iron, water-cooled, hearth, to which the slag would not adhere, or a totally removable hearth mounted on a wheeled truck, being employed. These arrangements made no provision for the gasification of the tar, etc., but involved the employment of subsequent operations of condensation, scrubbing, and purifying. Such producers have been made and operated successfully by the Deutz-Otto gas engine works, and tests by Professor Meyer, using Lausitz brown coal, containing 29 per cent of carbon, and 58 per cent of moisture, showed a gas of 1,272 calories per cubic metre, or 143 B. T. U. per cubic foot. Including gas engine tests it appears that the fuel consumption was from 1.5 to 1.6 kilogrammes per horse power, which is excellent when it is considered that the lignite itself had a calorific value of only 2,190 calories per kilogramme, or about 4,000 B. T. U. per pound; the power cost working out only about 0.6 pfennig per horse power per hour.

For the proper generation of fuel gas for internal combustion motors from lignites, however, it is desirable that the tarry

products be wholly converted into fixed gases, and two general processes are available for this purpose: either the tarry vapors are passed directly through an incandescent layer of fuel, or they are first burned, and the products then delivered into the burning fuel.

In the first case the hydrocarbons are decomposed into hydrogen, carbon, and methane, the carbon being separated in the form of soot, and then, in the presence of oxygen, converted into carbon monoxide; in the second case water and carbon dioxide are produced by the combustion, and these subsequently converted in the fuel bed into carbon monoxide and hydrogen. In many cases both operations are carried on together, when the tarry vapors are delivered, together with oxygen, into an incandescent layer of fuel.

Four different arrangements of gas producers have been devised in connection with the gasification of lignites for power-gas generation.

1. Simple gas producers in which the tarry gases are returned into the combustion chamber;

2. The combination of a simple gas producer with a separately-fired reduction furnace;

3. The reversed-draught generator, in which the air enters at the top and passes downward, the gas being taken off from the bottom;

4. The double-combustion generator, in which, in one and the same producer, the air is admitted from above and from below, the gas being drawn off between.

Herr Neumann gives a number of illustrations of gas producers designed according to these principles, with details of construction.

Especially interesting is the experimental research generator built by the Otto-Deutz company for the investigation of different kinds of fuels. This consists of two separate gas producers, one for the production of the mixed gas and tarry vapor from lignite or brown coal, while the other is a regular producer arranged for coke or anthracite coal. The latter is provided with tuyeres above the grate, for the admission of a determinate quantity of air, while the gas and vapors from the lignite in the first producer are delivered below the grate and pass up through the shaft of incandescent fuel. With this apparatus the proportion of coal or coke required to fix the tarry vapors for any variety of lignite can be experimentally determined, and valuable data obtained for the design of commercial producers.

In actual practice it has been found that the gas producer, using lignite with a calorific power of only 4,800 calories per kilogramme (8,640 B. T. U. per pound) gives a horse power in the gas engine with a consumption of 0.71 kilogramme, while a coal of 7,000 calories (12,600 B. T. U. per pound) burned under a boiler, and used in connection with a steam engine required 0.88 kilogramme per horse power.

AMERICAN RAILROAD OPERATION.

THE WORK OF THE MOTIVE-POWER OFFICER IN THE MANAGEMENT OF AMERICAN RAILROAD OPERATION

G. M. Basford—Purdue University.

IN common with several of the technical schools of the United States there has been established at Purdue University the system of presenting to the students some practical views of important departments of engineering work by independent lecturers of eminent standing. At Purdue especial attention has been given to locomotive work, this being the home of the first locomotive testing plant, developed under the care and effort of Professor Goss, and among the recent addresses recently given before the Mechanical Engineering Society under his charge we note that of Mr. George M. Basford, of the American Locomotive Company, upon the important subject of the work of the motive power officer in American railroad service.

The development of the locomotive during the past decade is a matter to which reference has frequently been made already in these columns, but Mr. Basford passes from this part of the subject to its natural

sequence, the increase in scope and responsibility of the men in charge of the railway motive department.

"American railroads are usually built along the lines of least financial resistance and improvement problems in grade reduction and curve specification were handed down to the present generation of managements. Improvements in yards, at terminals and at points in transit simplify the handling of freight, and soon the locomotive will receive its share of development. Heretofore it has grown chiefly in size, weight and power, but there remains another development in the direction of crowding the greatest possible capacity for power within the possible limits of weight and size. Economy of operation, while important, is less important to-day than the provision of the utmost possible capacity of the machine. Perhaps this may be more clearly stated by saying that the greatest need is for that which will extend to the utmost the capacity of the fireman and render the limited physical strength of a man capable of supplying the requisite power.

"This is the locomotive problem for the immediate future—to provide more power without greatly increasing existing weights. A secondary, but scarcely less important field for effort, is the improvement of design and method of operation which will reduce road service failures.

"Another opportunity for the greatest abilities lies in revolutionizing methods of motive power management to bring them into parallel with those methods which have brought the greatest successes in the management of vast industrial establishments. Altogether the motive power problem presents possibilities as great as those of any field of mechanical activity and these are worthy of the efforts of the best of men.

"Thirty years ago the head of the mechanical department led a comfortable life. He could safely follow precedent and the strenuous life had not been invented. Labor wars had not begun and the stirring emergencies of the present were unknown. It was easy to select shop machinery. There was no shop problem, no pooling of locomotives, no piece work price, no heavy locomotive or large capacity car and no train four-fifths of a mile long. No one cared much about the records of performance or cost of work. Workmen were better trained and good apprentice systems were in force. There was no tendency to go outside of a railroad organization to secure any official, and railroad ways and methods were those of smaller days. There were emergencies, of course, but not the emergencies of to-day. Thirty years ago the railroad official was a good man and as efficient for the time as the official of to-day, but he was a very different kind of official. His facilities were crude and his responsibilities not so great. Locomotives did not weigh 50 tons and other factors were in proportion. The superintendent was his own general manager and he knew every man in the train service. The master mechanic knew all his shop men and the engineers and firemen. He knew their history and he knew all about them and their affairs. Each locomotive had a name and an engineer and fireman were assigned to it. They went into the shop with their engine or they were laid off while it was repaired."

In discussing the locomotive problems of the present, Mr. Basford considers the questions of compounding, superheating, modifications in valve gear, and articulated construction, as well as the materials and methods for car construction.

So far as compounding is concerned, he believes that it is advisable, and that it must be increasingly employed, not especially because of possible fuel economy, but because of the imperative necessity for increased capacity. The increasing weight of freight trains and the increasing severity of passenger schedules, these are the things which must be faced and met, and which, in the opinion of those most competent to judge, demand that the locomotive of the future must be a compound engine.

Superheating is not antagonistic to compounding, but aids in reducing heat losses, with corresponding improvement in economy, efficiency and capacity. With compounding comes also the advantages, in the four-cylinder engine, of balancing, this permitting hammer-blow action on the rails to be replaced by a practically constant pressure. Since this enables the weights on the driving wheels to be increased without

a corresponding increase in destructive action on the track, this again permits larger boilers to be carried, an absolute essential to material increase in capacity.

Improvements in valve gears are largely included in the question of general design, since the steam distribution may be effected in a great variety of ways. The Walschaert gear has been in use in Europe as long as the link motion has been employed elsewhere, but it has been introduced generally in the United States only since four-cylinder compounds have rendered an outside gear desirable, and since the necessity for preventing further increase in the weight of the gear has become apparent. As a motion it leaves little to be desired, and its mechanical advantages are obvious.

"As yet, comparatively little has been done in the improvement of the locomotive in this country in the direction of superior economy and efficiency. In Europe the high price of coal has led to care in design and in operation of locomotives which is unknown here. The French are a generation in advance of us in locomotive operation. In France, locomotive engineers use devices such as double valve gears and variable exhaust nozzles, which we do not intrust to our engineers and firemen. In England, the small number of locomotive failures on the road are a revelation to any one who studies them from our standpoint. In England, the locomotive is given a fair chance by receiving fair treatment, yet it probably does not cost more in the end. We certainly have much to learn from across the water, and while what we may learn is not so much in practice as in method, it is none the less important. That which we most need to learn from England is the value of appreciation of the locomotive and locomotive men. This will be learned and well learned—probably in the near future—of this we may feel sure. We may safely count that when those who are now students are ready to be leaders of mechanical departments of our railroads, the position of the department head will have become an enviable one. There is no field of mechanical work so full of opportunity as this and much depends upon those who are now fitting themselves for the leadership of to-morrow. These leaders may be in the ranks; they may be in the colleges, but wherever they are their preparation must be thorough, for their work is to be great and it will grow to be still greater.

"The idea of the importance of the mechanical problem when demonstrated on a large scale is suggested by the fact that January 1, 1906, a combination of 54 railroads controlled by the Vanderbilt interests became known as 'The New York Central Lines.' All cars, stations, locomotives and all the office stationery used in transacting the business of these 54 roads will bear this name. This enormous combination of responsibilities is not as impressive in any other of its phases as it is in the matter of the motive power responsibilities. The question of design, of construction, of locomotives, of shops and many other questions which are comparatively small on the individual roads of this combination now become great because of the effect of the practice in one portion of the system upon that in another. It is easily understood that such an aggregation of interests renders it necessary to prepare, through careful study, for every change in practice. The design of shops cannot be made without most thorough and careful consideration of practice in other parts of the system, made with the view of adopting the best in every detail, and the same applies with even more force in the case of locomotives. All this points to the necessity for very high authority to properly administrate these responsibilities. In this discussion, only the high points are touched upon, many others being unmentioned because of the lack of time.

"There seems to be no need of arguing at this time in favor of placing full and complete authority for such important problems in the hands of an official who stands immediately next to the throne. This, when done, will mean much to American railroads."

The view which Mr. Basford holds as to the functions of the motive power officer of the modern American railroad agrees closely with that which has been expressed editorially in this magazine more than once for the higher work of the engineer in nearly all departments of his profession. Formerly the highest position to which an engineer, in railroad work, in

manufacturing, or in construction, could expect to attain was that of a chief of a department, his duties being confined very generally to the close conduct of actual engineering work. To-day it is becoming evident that the opportunities, possibilities, and ultimate scope of the work of the engineer lead directly to executive and administrative control, and this is true, not only of the motive-power officer but of the responsibile engineer in all large undertakings.

"It is the ship with its bunkers full, its engines tested, its captain forewarned, its straight line voyage charted, that breaks the record into port.

"And it is the minute of talk after the hour of thought, the ounce of effort after the ton of preparation, that steers a business project into the harbor of success."

DEEP MINING IN GREAT BRITAIN.

CONSIDERATIONS UPON THE PROBLEMS INVOLVED IN THE EXPLOITATION OF THE DEEP UNWORKED COAL FIELDS OF GREAT BRITAIN.

George Farmer—Institution of Mining Engineers.

WE have already reviewed in these pages the report of the Royal Commission on British coal supplies, and commented on the fact that this report included only such coal resources as exist at depths not greater than 4,000 feet. Since this limit is distinctly deeper than present workings it has been a matter for consideration as to the difficulties which might have to be encountered in reaching such deposits, and this question forms the subject of a paper by Mr. George Farmer, presented at the recent meeting of the Institution of Mining Engineers.

It is generally admitted that there are serious physical difficulties connected with workings at such depths, these including the effects of crush, and the increase in temperature, to which may be added the problems involved in the use of mechanical appliances, and the general adoption of the long-wall system; and above all, the increased cost.

So far as the question of temperature is concerned, there is no doubt that this is a serious matter. According to the report of the Commission of 1871 it seems probable that the temperature would reach 98 degrees F. at a depth of 3,000 feet. Allowing for the difference between the temperature of the air and the face of the long-wall, it appears that the temperature of the blood would be attained at a depth of about 3,240 feet. The oppressiveness of such a temperature depends to a great extent upon the humidity, but it is believed that at the greater depths the dryness would render the heat more endurable than at shallower workings where more moisture is present.

"It might be thought, perhaps, that an effective ventilation might so keep down down the temperature as to give the ability to work at great depths. The rapidity with which the air takes up heat from the working-faces depends to some extent on the system of working, and this absorption only ceases when complete assimilation of the temperature as to give the ability some cases, under the long-wall system, the air has retained an inferiority of temperature after sweeping past the coal-face. An increased ventilation may be obtained by increasing the ventilating power and the velocity of the air, but only at an excessive cost. Or an increased ventilation may be obtained by making more intake-airways into the coal-face, but here again an excessive cost interferes, while extra airways would certainly afford extra surfaces, from which the air would take up heat. Another suggestion is to make the airways larger than at present. It is not supposed that an increased velocity would either increase or decrease the temperature, for Sir Lindsay Wood has shown the approximation of the temperature of the air to that of the strata through a distance of 10,266 feet; and he found at that distance, that no perceptible difference took place in the temperature of the current when reduced from 41,800 cubic feet to 3,000 cubic feet per minute. It has been found, however, easier to work in velocities of 8.25 feet per second, and the atmosphere at 100 degrees F. than in weak currents with a temperature of 86 degrees

F., especially where the atmosphere is dry. This is explained by the refreshing feeling due to the evaporation of the perspiration on the workman's body.

"Another suggestion worth consideration, perhaps, is the possibility of cooling the air. Water has been tried for this purpose, but the use of water upon shale at a high temperature causes it to swell, and may lead to a prohibitive expense; at the same time, it may render work uncomfortable owing to the combination of moisture with high temperature. Compressed air, passed through condensers, surrounded by cooling jackets, and then conveyed in pipes down the shaft and delivered in the roadways of each district, or delivered near the coal-faces, would certainly assist in cooling the air, and reduce the percentage of moisture, but at what cost? A suggestion worthy of consideration and discussion is the possibility of using liquid air. Its use would be quite safe, whilst it may be applied both to cooling and haulage purposes.

"The coal-dust question will become more serious than at present. Since the prevention of accumulations of layers of fine coal-dust on the supporting timber and sides of the roadways is utterly impossible, and, moreover, its inflammability is increased by the high temperature, it would appear reasonable to adopt some means of rendering the dust a non-supporter of rapid combustion. It will not be wise to use water, which has hitherto been considered to be nature's medicine. It was shown before the Royal Commission on Coal Supplies that dry air was the only sort of air in which miners could work in a deep mine; from the fact that dry air absorbed the perspiration from the men's bodies, whereas if water was used, in the form of spray or otherwise, the air would become saturated to such an extent that effective work would be an impossibility."

So far as the working of seams at such depths as are under consideration is concerned, it appears that the long-wall system is advisable wherever the thickness of the seam will permit. The report of the Commission, however, considers the working of seams as thin as 12 inches, and in such cases it will be found imperative to adopt the universal use of both coal-cutting machinery and coal conveyors.

The high velocities of air currents necessary for adequate ventilation renders it important to consider the question of lighting, and it seems that portable electric lamps might be employed to advantage, especially since they do not abstract oxygen from the air. The probable presence of fire-damp renders it important that some form of detector, such as a diffusion cell on an electric lamp, be used, and it is recommended that one man be made wholly responsible for the safe working of each stall. In regard to danger from explosives, this is a matter which will have to be determined when the condition of such workings with regard to fire-damp is revealed in practice. It seems altogether possible that substitutes for explosives, such as the lime cartridge, may be found available, and remove danger from this source.

The problems of deep winding have already been encountered at length in metal mining, both in Europe and America, as well as in South Africa, and there appears to be no good reason why the experience thus obtained may not be used to advantage in deep colliery pits.

"In summarising the various problems discussed, Mr. Farmer considers that close attention and consideration will be needed to reduce sufficiently the temperature of the mine so as to afford a reasonable amount of comfort to the workmen. This may be done by using compressed air as a motive power in and about the workings, the air being compressed by electric motors near the pit-bottom or on the main intake-airways, so as not to reduce the efficiency. The use of water would be injurious to health, and at the same time ruinous to the adjacent strata.

"Ventilation will be needed to flow at higher velocities, because it is found that men can work in a high temperature with air at a high velocity, better than in the same temperature, or even a lower temperature, at a low velocity. Quicker velocities will lead to improvements in the safety-lamp or in the adoption of the electric hand-lamp.

"Explosives will only be used with extreme caution; and it is quite likely that efficient substitutes for explosives may be found.

"The long-wall method of working, it is

quite likely, will be universally adopted, owing to its adaptability to a simple and adequate ventilation. The coal-faces will be worked forward in a regular line, followed by a regular line of timber, both being conducive to a regular line of break; and for this purpose, coal-cutting machines will be more extensively used. The faces will be set out in long lengths, and the coal will be carried along the faces by means of coal-conveying machinery.

"The main haulage will be carried out by means of electrically-actuated power plant situated at or near the pit-bottom. Machinery may also be used to compress air for use as the motive power of secondary haulage, coal-cutters, coal-conveyors, etc. From this machinery, or other machinery on the same cables, air will be compressed for cooling purposes.

"Careful consideration will be given to the question of spontaneous combustion, in the laying-out of the workings; and the mine must be laid out and worked with the intention of preventing the occurrence of gob fires.

"The shafts and winding appliances will be designed and installed with the view of dealing with a large nett load, in a minimum time of winding. The guides must be rigid, and probably a more extensive use of steel rails will be adopted. In dealing with the load in the shaft, counterbalancing will be found inevitable, but the use of such a counterbalance should not put any extra strain on the capping of the winding-rope. In some cases, a system of dealing with the load at stages in the shaft may be adopted, or some system of winding with the use of tipping-boxes. Where such a system is used, however, it may be found advantageous to use the upcast shaft for winding purposes, on account of the large amount of dust.

"The writer is aware that the cost of fitting an ideal mine might become prohibitive, as the working of seams at depths of 3,000 feet to 4,000 feet would entail the expenditure of much capital in the sinking of wide shafts, and in the laying out and equipment of the surface and underground works; and, to ensure an adequate return, the most rigid economy must be exercised and practised."

CORROSION OF IRON AND STEEL.

CAUSES FOR THE DIFFERENCE IN THE SUSCEPTIBILITY OF IRON AND STEEL TO CORROSION IN MECHANICAL STRUCTURES.

Henry M. Howe—American Society for Testing Materials.

AT the recent meeting of the American Society for Testing Materials there were presented several papers dealing with the problem of the corrosion of iron and steel. Among these was one by Dr. H.M. Howe in which some of the popular opinions as to the relative resistance to corrosion of iron and steel are compared with scientific observations upon the same matter.

Since the general introduction of steel for iron in nearly all departments of construction it has been found that steel is vastly superior in many respects, but there have been maintained certain views as to corrosion which, if true, become very important in some special cases. It is generally believed that wrought iron does not corrode nearly so rapidly as steel, all other things being equal and in locations where resistance to corrosion is essential many engineers will use wrought iron, if it can be obtained. One of the objections to steel pipe is the general belief that it corrodes much more rapidly than wrought iron, while experience seems to confirm the view that iron resists the corrosive action of gases, as in boiler stacks, overhead railroad bridges, etc., far better than steel.

Dr. Howe reviews these opinions in the light of accurate observations, and succeeds in disposing of some of the charges against the behavior of steel, while others are suggested as suitable for further exhaustive scientific investigation.

"On one hand we have the very general public opinion that steel corrodes not only faster but very much faster than wrought-iron, an opinion held so widely and so strongly that it cannot be ignored. Smoke does not prove that fire exists; but such strong smoke bids us look carefully for

fire. On the other hand we have the results of direct experiments by a great many observers, in different countries and under widely differing conditions; and these results certainly tend to show that this popular belief is completely wrong, and that on the whole there is no very great difference between the corrosion of steel and wrought-iron. Under certain sets of conditions steel seems to rust a little faster than wrought-iron, and under others wrought-iron seems to rust a little faster than steel. Thus taking the tests in unconfined sea water as a whole, wrought-iron does constantly a little better than steel; and its advantage seems to be still greater in the case of boiling sea water. In the few tests in alkaline water wrought-iron seems to have the advantage over steel, whereas in acidulated water steel seems to rust more slowly than wrought-iron."

Dr. Howe calls attention to the fact that with the general introduction of steel into structural work there has been also a great increase in sulphurous acid in the air of cities, while at the same time the presence of stray electric currents in the ground has introduced another cause of corrosion. Hence it is altogether possible that metallic structures may be more subject to corrosion than formerly, and yet this increased corrosion may be due to causes independent of the change in the materials themselves. It is admitted that popular beliefs, while lacking in scientific precision, are generally based upon a larger number of observations than are possible in the laboratory, and a greater variety of conditions of service, and hence they should not be hastily discredited, but given due weight in connection with scientific investigations.

"In view of this great discrepancy between popular belief and the results of our direct taste, it behooves us who have relied chiefly on these latter to examine their conditions carefully, to see whether they really have represented fairly the conditions of actual industrial use and service, in such a way that, if there is a real difference between the corrosion of steel and that of wrought-iron, such a difference would become manifest. In short, have our direct comparative tests been trustworthy?

"Now, when I review our conditions in the light of this apparent contradiction between popular belief and the results of the differences between steel and wrought-iron which ought to cause a difference in their rapidity of rusting, there are three prominent differences: (1) Blowholes; (2) Manganese; and (3) The presence of cementite in the steel and of cinder in the wrought-iron. Let us take these up in order and see how they require that direct tests should be very prolonged or pushed to destruction.

(1) Blowholes exist in steel but not in wrought-iron. But blowholes, at least blowholes which do not weld up and thus cease to exist, are not necessary. Yet they are to be prevented only by care and skill. Hence, get your steel only from careful and trustworthy makers.

(2) Steel always and almost necessarily contains more manganese than wrought-iron. This may or may not hasten its rusting. If it does, then its effects ought to be made manifest even in short-time tests. From the fact that such tests do not show that steel rusts materially faster than wrought-iron, I infer that this manganese is probably not a serious cause of rusting.

(3) Steel is generally richer than wrought-iron in cementite, the iron carbide Fe_3C. Wrought-iron always contains very much more cinder than steel. Each of these substances, the cementite of the steel and the cinder of the wrought iron, may have a double influence on corrosion, hastening it through difference of potential and retarding it by acting as a mechanical barrier like so much paint, to exclude the oxygen or the air or the water. It is not clear that the influence of difference of potential ought to change materially as corrosion proceeds; but it is clear that that mechanical protection given by the plates of cementite and of cinder ought to increase as corrosion proceds. When a piece of wrought-iron, for instance, is first exposed to corrosion, only the outcrops, so to speak, of the sheets of cinder come to the surface; its mechanical protection is very small. But as corrosion proceeds, and more and more of the metal which at first overlay the sheets of cinder is eaten away, the remaining cinder forms a larger and larger proportion of the outer surface, and therefore protects a constantly increasing

proportion of the underlying metal from corrosion. In short, the mechanical protection afforded by the cinder ought to increase as corrosion proceeds. Here, then, is a cause which, as corrosion proceeds, should continuously tend to retard the corrosion of wrought-iron, and to make it compare more and more favorably with steel. But, in like manner, as steel is gradually corroded away, more and more of its surface should come to be composed of cementite, and this fact should tend to retard the corrosion of steel, because cementite, too, should protect the underlying free iron or ferrite.

"These causes may, in time, reverse the initial relative rapidity of rusting of steel and wrought-iron. Steel which in the first few months may rust faster than wrought-iron may, on greatly prolonging the experiments, or pushing them to destruction, actually rust more slowly, and vice versa.

"Now of the two, the cinder of wrought-iron ought to gain more than the cementite of the steel, in its value as a mechanical retarder of corrosion, as time goes on and more and more of the metal is eaten away. The reason for this is that the cementite is in such extremely minute microscopic plate that the eating away of a very small quantity of the iron from above them ought to bring very nearly the full proportion of this cementite to the surface; whereas the much larger and more distantly scattered plates of cinder in wrought-iron would not constitute their full share of the surface until a much thicker layer of initially overlying metal had been eaten away. This, then, may be the true explanation: that is, the reason why steel does not rust faster than wrought-iron in our direct tests, though it does in actual use, is that our direct tests are too short to bring out the full protective action of the cinder of the wrought-iron. Or the reverse may be true. As time goes on, the harmful effect of the difference of potential of the cinder may grow more than its protective action. Let us, therefore, henceforth push our tests to destruction."

THE COURRIERES MINE DISASTER.

A DETAILED ACCOUNT OF THE NATURE AND CONSEQUENCES OF THE FIRE AND EXPLOSION IN THE COURRIERES COLLIERY.

E. Lemaire—Le Génie Civil.

WE have noted already in these reviews the great disaster at the Courrières coal mine, which occurred in March last in the Leus district in the North of France, and as additional technical information is given to the public we shall endeavor to supplement the earlier notes with the later matter.

In recent issues of *Le Génie Civil* there have appeared articles by M. E. Lemaire, describing the general character of the workings of the colliery, the nature of the disaster, and some of the questions relating to the responsibility for the loss.

The mines at Courrières included eleven seams of varying importance, actively worked by nine shafts, the total quantity of coal raised during 1905 being about 2,400,000 tons of semi-bituminous and anthracite coal or about one-fifteenth part of the total production of France, the company employing more than 8,000 miners. The map of the property, given by M. Lemaire, shows the arrangement of the shafts very clearly, while a section gives the general position and depths of the seams, these ranging from about 200 to 400 metres below the surface. The development of the workings in the more important veins is very extensive. Thus the Josephine vein, 2.25 metres in thickness, at 326 metres depth, contains the best quality of coal on the property, the workings extended for a distance of 3 kilometres, while in other veins workings of 1.5 to 2 kilometres have been made.

Owing to the nature of the coal but little fire damp has been evolved, and until the recent disaster the mines had been comparatively free from trouble of this kind. The system of ventilation had grown up with the development of the property during the past fifty years and while not that which might have been installed had the whole undertaking been arranged at the present time, it appears to have sufficed.

At three of the nine shafts in active operation there were exhaust fans installed, the air descending the other shafts, and being directed through the various workings below by suitable partitions and doors.

Several days before the explosion it was discovered that fire existed in the gob in the Cécile vein, reached by shaft No. 3, this being one of the shafts through which air was admitted to the mine. The arriving air, in the regular course of ventilation, descended to the bottom of the shaft, a depth of 326 metres, and after passing through several workings, including the one in which the fire appeared, it ascended to the 280 metre level, and was returned to the shaft, in which an uptake passage was partitioned off from the main pit, the upward current being produced by means of a small Guibal fan. This fire was promptly dealt with, and walled up to smother it out by depriving it of air, and this work was deemed to have been entirely successful until, on the morning of March 10, an explosion of great violence occurred, the force of the discharge from the mouth of shaft No. 3, being so great as to kill a passing workman by hurling him against a ladder. The shafts immediately connected with No. 3 were pits No. 2 and 4, and at the time of the explosion there were 1,795 miners in the corresponding workings. Of these 550 escaped immediately after the force of the discharge subsided, leaving more than 1,200 below.

The work of rescue has been fully told already, and the immediate efforts of the engineers, supplemented by the invaluable assistance of the Salvage corps, equipped with artificial respirators, from the famous Shamrock Hibernia Mine, in Westphalia, succeeded in effecting the escape of about 100 more men, the final record showing a loss of 1,101 lives.

The latest investigations as to the probable causes of the explosion are given very fully by M. Lemaire. None of the workings involved in the disaster had shown previous evidence of fire damp or excessive dust. So little gas was produced that it was common to permit the use of uncovered lamps in these workings, safety lamps being required only as a matter of precaution at the 380 metre level, where a slight disengagement of gas appeared.

However the fire may have been started, it was at first a simple combustion without any of the elements of an explosion. The walling up of the passages certainly checked its activity, converting its action into a sort of slow distillation, and apparently the resulting combustible gases forced their way through seams in the vein and in the rock, this action being doubtless accelerated by a sudden drop of nearly 2 centimetres in the barometric pressure, thus emphasizing the difference between the internal and external pressure. It is probable that there was a preliminary explosion of the coal gas thus formed in the distilling coal, and that this explosion disengaged large volumes of coal dust which had been lying inert undisturbed. The great explosion, which must have followed almost immediately, was then a dust explosion, one of the most deadly which can occur in mining work.

A simple explosion of fire damp can take place only upon mixture with the proper proportion of air, and the ensuing combustion vitiates only the amount of air required for the combination. The produet of the combustion, moreover, is principally carbon dioxide, a gas which is inert rather than poisonous. With a dust explosion, on the contrary, the combustion is almost always incomplete, as is proved by the residue of coke, and the product of the combustion is the extremely poisonous carbon monoxide. The combustion is propagated with extreme rapidity, with all the characteristics of a real explosion, *all* the oxygen in the surrounding air being consumed and replaced wholly with carbon dioxide and especially with the poisonous carbon monoxide.

That the principal explosion was due to dust, and not to gas, is evident by the presence of a fine deposit of coke dust upon the timbering and elsewhere in the damaged workings, so far as they have been inspected. This is one of the important facts bearing upon preventive and protective measures which may be taken hereafter, both in the Courrières mines and elsewhere. It is evidently not enough to assume that the general absence of gas renders a mine safe from disastrous explosion, the dust question must be met and treated in a manner as effectively as has

the fire damp danger by the perfection of the modern safety lamp.

The loss to the mining company is doubly great. Until the workings can be restored to their full efficiency, the output of the mines will be reduced by about 500,000 tons per year. In the payment of pensions to the families of the miners killed in the disaster there is involved an amount of nearly a million francs a year. The large number of employees of the company had led the administration to effect its own liability insurance, and the invested funds for this purpose in this case amount to about 14 millions of francs, so that the payments required in consequence of the disaster will absorb more than the income on the entire amount.

M. Lemaire gives an abstract of the French law upon the subject of mining management, which is of local value and interest, and his entire discussion of the affair is altogether judicial, temperate, a..d scientific.

HOISTING MACHINERY FOR MINES.

COMMERCIAL POSSIBILITIES OF ELECTRIC WINDING MACHINERY FOR SHAFTS AND AUXILIARY MINING WORK.

W. C. Mountain—Institution of Mining Engineers.

WITH the general applications which are being made of electric power to the operation of machinery of all kinds it is natural that the subject of the electrical driving of winding machines in mines should be advocated. Since such machinery is naturally brought into comparison with steam winding engines it is desirable that any examination of the subject should be made upon conditions which are scientifically comparable, otherwise the conclusions are apt to be misleading. In a paper presented by Mr. W. C. Mountain at the recent meeting of the Institution of Mining Engineers the relative value of steam and electric winding is discussed, taking into account the actual operative conditions as deduced from British and German practice and showing the reasons which should influence the choice of system in either case.

"The great mistake which writers on this subject have made in the past is that they only compare the results of electric winding with old-fashioned uneconomical steam engines, but in order to get a true comparison it is necessary to make the comparison on equal lines.

"The advocates of electric winding content themselves, as a rule, by making a statement that the consumption of steam per 'useful horse-power' is anythingfi varying from about 27 to 31 pounds, and they quote the consumption of steam for steam winding engines as from 50 to 150 pounds, (the figure generally approaches the latter), and having done this, they consider that they have satisfied the mining engineer that electric winding is necessarily much more economical. The data given in this paper show how erroneous is this conclusion, because in some collieries the value of the coal burned under the boilers is of such a low grade, and of so little value, that an enormous saving would be necessary to make up for the difference due to the greatly increased cost of the electric plant, and the interest and depreciation which must necessarily be added.

"To those who are not acquainted with the meaning of the words 'useful horse-power,' it might be desirable to explain that this means the theoretical horse-power required to raise a certain quantity of coal during the winding day, assuming that the winding was continuous. It will be clear to all practical mining engineers that such a term is of no practical value, because in shallow pits the number of winds per day is very considerable, and it is well known that the power required to start the load, that is, to accelerate, is very greatly in excess of the average power. In deep pits, it takes no account of the weight of the winding-rope, or the great amount of power necessary to accelerate the large and heavy drums which are required to carry the long length of rope. From many calculations, the writer has found that it is necessary to multiply the 'useful horse-power' by 1.5 for deep shafts, and by as much as 2 for shallow shafts, to get the average

horse-power, and to this again must be added the power necessary for the weight of the rope, when the rope is not balanced.

"On the Continent, the success of electric winding is largely due to the use of the Koepe system, which is really an endless rope-wheel, the rim being fitted with hard wood segments, with a turned groove into which the rope fits. Of course, by this system, it is necessary to have a balance-rope, and further, it is not usual to use keps at the pit-head; this makes the banking-out or changing very slow, as the load is brought quietly to rest, otherwise there would be a risk of the rope slipping in the groove. There is a further danger by this system of both cages going to the bottom of the shaft in case of the rope breaking, but this, of course, is a remote contingency and one which appears to be worth very little consideration.

"The advocates of electric winding have also made many claims such as: (*a*) Quicker acceleration; (*b*) greater simplicity; and (*c*) greater safety appliances. The writer feels sure that whilst no doubt electric winding is extremely steady owing to the even turning moment of the motor, with a well-balanced engine winding by steam is perfectly satisfactory, and unquestionably quicker acceleration can be obtained with a steam engine than with an electric motor. The safety appliances which are fitted to an electric winder are fitted on all high-class modern winding engines, and as regards simplicity it is impossible to imagine anything better than a steam engine directly coupled to its winding drums; whereas with the balancer system of electric winding, there are, between the steam engine and the winding drums, the generator, switchboard, cables, motor, flywheel running in two bearings, generator, switchboard, connecting cables, and two motors on the winding gear. This apparatus, if well constructed, should give little or no trouble, but it is foolish to bring forward simplicity as one of the advantages when there are all these links in the chain, and the failure of any one of them would throw the whole gear out of work."

In gathering the data for comparison Mr. Mountain has been careful to select results from a number of large collieries, tabulating the figures very fully, and thus making public the facts upon which his conclusions are based. The costs are computed for the actual cost of winding, and also include provision for interest and depreciation, this being taken at 5 per cent., for interest and 5 per cent. for depreciation, the final results being reduced to the cost of winding per 100 tons. The detailed data may be consulted by reference to the original paper, but the general conclusion is that for existing steam plants for large outputs, coal can be wound, including interest and depreciation, at from 5 to 6 shillings per 100 tons.

Similar studies follow for electric winding, considering the data to be the same as to quality, depth of shaft, and time. In the electrical estimates the cost of the primary power-generating plant is taken for an equipment necessary to operate only the winding plant, not including power which might be required for other purposes about the mine. In order to provide against emergency breakdowns, three units of equal size were assumed, with a fair margin of excess over the total power required. Thus, if the size required were 2,000 kilowatts, the plant should consist of three units of 800 kilowatts each, so that the three would run somewhat underloaded and efficiently, while in case of breakdown, two of them could continue without being excessively overloaded. The figures for the electric plants have been based upon actual estimates of the cost of winding plants, providing for slowspeed motor generators and for ample capacity in the proportion of the generating plant and in the boilers to deal with the work, and they are based upon a steam consumption of 25 pounds per kilowatt-hour.

The results of the computations, together with the original data are again carefully tabulated, and the costs work out about double that for high-class steam winding, or about 10 shillings to 12 shillings per 100 tons of coal raised.

Mr. Mountain admits that the conditions to which electric winding are applicable vary so much that each plan should be investigated on its own merits, and his principal contention is that in such investigations the correct data and conditions should be considered. He therefore sets forth the following scheme of data to be used in

studying any proposed application of electric power to winding, as necessary if a reliable comparison with steam power is to be obtained. The necessary data are:—

(1) Depth of shaft.

(2) Tons of coal per day.

(3) Time of winding.

(4) Value of coal used under the boilers, and this has greater influence than anything else upon the commercial possibility.

(5) Whether the winding is done from one pit only, or the current is supplied from a central station to a group of pits, and from an electric power company.

(6) If supplied from a power company, the cost at which they will supply current per unit.

(7) The amount of work outside of the winding, which has to be done in the way of pumping, hauling, coal-cutting, surface-driving, etc., in order to ascertain to what extent the load can be levelled, and whether it is necessary to adopt the balancer system or to use three-phase or continuous-current direct.

"It is quite possible (after full consideration of all the above-named points, and particularly if the current can be supplied from a central station to a group of collieries, say, three or four, or more) that the electric energy can be produced at such a low price that it may pay to spend more money on the winding gear and to adopt electricity for every conceivable purpose throughout the pit. Under these circumstances electric winding will have a fair chance, but where heavy winding is to be done at a single colliery and the winding absorbs probably two or three times as much power as the rest of the machinery, and is also only running, say, eight to ten hours per day, there can be no doubt that it is almost impossible to compete with high-class steam engines.

"Another point which is often overlooked in connection with electric winding on the balancer system is that it is necessary to keep the balancer running for practically 24 hours per day, because, after the day's winding is done, the winding engine is used during the night for occasionally lowering down men, timber, etc., and this involves running the large generating plant for 24 hours per day to keep the balancer running. This is necessarily very costly and wasteful, and far more than compensates for the loss in condensation in steam pipes with a steam winder."

GASOLINE RAILWAY MOTOR CARS.

INDEPENDENT MOTOR CARS FOR LOCAL AND SPECIAL SERVICE ON MAIN-LINE STEAM RAILWAYS.

F. W. Hild—Iowa Street and Interurban Railway Association.

WITH the development of the local and interurban electric railway there has naturally come efforts on the part of the steam railroads to meet the cheap and convenient competition which has thus appeared against local railway service. At first the tendency appeared to be a policy of dropping many accommodation trains, permitting the paralleling electric roads to have the local business and refusing to meet the lower fares and more frequent service.

In some places this was followed by a systematic policy on the part of the steam railroads to acquire controlling interests in the various electric lines, using them as feeders to their own stations and generally regulating their operation so as of interfere as little as possible with the main lines, while returning a fair profit on the investment. This has been followed of late by a tendency to imitate European practice by introducing the independent motor car, a self-propelled car, carrying about as many passengers as the ordinary trolley car, and adapted for independent operation on the main-line tracks between regular train schedules, meeting the demand for local passenger service. Such independent cars are designed with various methods of propulsion, some having steam engines and boilers, others being fitted with internal-combustion engines, burning gasoline, much in the same manner as the motors of automobile vehicles, there being almost as many varieties of motive-power machinery as there are builders.

In a paper recently presented before the

Iowa Street and Interurban Railway Association by Mr. F. W. Hild, the subject of the railway motor car is discussed at length, especial comparison being made between the gasoline motor car and what is termed the straight electric system, this latter being the regular electric traction system in which the current is supplied from a stationary power house and delivered to the cars along the route. Mr. Hild is evidently an advocate of the straight electric system, and indeed he plainly states that his paper is a discussion of the subject from the viewpoint of the electric railway engineer, and he gives some interesting facts and figures for use in the study of the question.

"That the large roads have keenly felt the electric railway competition has long been known and it is now particularly evidenced by the various methods under consideration for meeting it. Thus the Union Pacific has built at its Omaha shops a straight gasoline car, wherein the power output of a gasoline engine is mechanically transmitted to the car wheels. The Chicago, Burlington & Quincy some months ago built at its Aurora shops, and for a short time experimentally operated, a gasoline electric car, wherein the power output of the gasoline engine was transmitted electrically to the wheels. The Delaware & Hudson has placed in operation a gasoline electric car built by the General Electric Co. The Lake Shore is also trying such a type of car. The Ohio River & Columbus Ry., according to the technical press, is experimenting with a steam propelled car, which is to be a modern edition of the old time steam dummy. The press very recently described the Strang electric railway car, a gasoline electric car which ran with its own power from Philadelphia, where it was built, to Kansas City, where it is to go into service on an interurban road in that vicinity.

"The writer has seen experimental outfits utilizing the automobile principle of carrying the motive power on the truck frame. In one case it was a high pressure superheated steam engine with direct chain transmission and with flash boiler, kerosene or gasoline pan burner, radiating condenser, etc., all very much the same as the equipment of the well-known "White" steam automobile. In another case it was a four-cylinder gasoline engine, with friction disk transmission, etc., similar to automobile equipment.

"The independent motor car idea had its inception abroad and much more work has been done in this direction in France, Germany and Great Britain than in this country. The most conspicuous application of the idea is the steam motor cars of the Great Western Railway of Great Britain. This railway has in use a number of modernized steam dummy cars using coal as fuel for steam generation. The preference on the continent seems to be for the internal combustion engine and several experimental gasoline engine cars are being tried. The Wurtemberg Street Railway is one of the most aggressive of foreign roads in trying the independent motor car. This railway has experimented with electric storage battery cars, with steam motor cars of the Serpollet type and gasoline cars of the Daimler motor type. It is interesting to note that the Wurtemberg Street Railway put an independent gasoline motor car into service in December, 1893, something over 12 years ago.

"There can be no doubt that most of the several types of self power-contained cars will find useful fields of application and will become valuable auxiliaries to the standard forms of rail transportation; but also, in the judgment of the writer, there should be no doubt that these fields of application will be relatively restricted and do not include such as are now served by the standard electric system."

That electric traction has been brilliantly successful in city urban and interurban service is generally conceded, and any service upon main railway lines which can compete with it successfully must possess the same qualifications of reliability, high speeds and frequency, cleanly and noiseless operation, and low cost of operation and maintenance. These are the features which already characterize straight electric traction, and which should be met by any system intended to meet it in commercial competition. The drawbacks to straight electric traction are obvious, being the necessity for the establishment of large power stations and extensive power transmission circuits, and the consequent very large initial financial

investments. The self-propelled car, on the contrary, appeals to the railroad man by the very reason that it, like the steam locomotive, carries its own motive power with it; besides which the initial investment is limited to the car itself, demanding no change or addition to the existing permanent way or equipment.

Assuming the gasoline car as typical of the best designs of self-propelled railway motor car, Mr. Hild proceeds to discuss some of the features of its construction.

"Apparently the greatest difficulty encountered by the designers of the gasoline cars is the transmission of power from the engine to the driving wheel. This is not surprising in view of the fact that the internal combustion engine is essentially a constant speed motor, and that railway work demands wide ranges of variable speeds. At the present time the favorite means appears to be the use of electricity, indicating that the difficulties of direct mechanical transmission and variable speed operation are so great as to warrant the rather roundabout transmission involved by the addition of generator, with or without batteries, and the standard railway type motors and control. Indeed it is claimed by the promoters that the efficiency of the gasoline electric outfits compares very favorably with any type of mechanical transmission and moreover, has the greater advantages of large variations of speed, flexible driving, ease of control, and lesser wear and tear. The acceleration and changes of speed are smooth, and without the jar or shock which is ever present with any mechanical change-speed gear. This situation suggests to electrical engineers the early discussions of series vs. shunt motors for railway work. The designers of the gasoline-electric cars, while fully agreed as to the method of power application, nevertheless differ among themselves on the important question of power supply —thus some insist that a storage battery is an indispensable adjunct, for the reason that gasoline engines have low efficiencies at fractional loads and furthermore have practically no overload margin; the battery, therefore, is needed to take care of the recurring inevitable overloads. Others, however, prefer to use a much larger generating unit, largely because of the saving in weight and space, and the avoidance of acids and fumes."

As already indicated, the subject is discussed by Mr. Hild from the view-point of the electric railway engineer, and hence he advances numerous arguments to show the superior advantages of the latter system. Such arguments are really hardly necessary, since the advantages of complete electric equipment are very generally conceded. The self-propelled car is really intended to fill an intermediate place between the steam-locomotive-drawn train and the complete electric service, and it is upon this basis that it should fairly be considered. As Mr. Hild shows, the maintenance charges for the self-propelled car will doubtless be greater than for the straight electric system. Operating costs, in like manner may be shown to lie somewhere between the straight electric and the steam locomotive service. For the intermediate period of transition, and for the intermittent and special service, however, the self-propelled car appears to have its own proper place, whether propelled by a gasoline motor or by a steam engine, the choice of motive power naturally depending upon local conditions.

"Managers of steam railroads entrusted with the direction of large vested interests, are naturally very conservative and therefore slow to make what would appear to be radical changes in their equipment. Therefore, while they realize the limitations of the steam locomotive in suburban and interurban service, they will, before stringing the trolley wire over their tracks, try out pretty thoroughly the independent motor car, which holds out alluringly the suggestions of interurban service without the power-house, without the track bonding and without the external transmission circuit. This try-out will definitely establish the true field of the self-contained car, and, in the writer's judgment, this field will be the very short spurs of existing steam railroads, serving sparse population, making infrequent trips principally to connect with main lines. Take one road—the Burlington for example; the Galena Junction shuttle train operating on a five-mile spur, and meeting the more important trains of the main line; and the Dubuque shuttle train which operates on the mile and a quarter

spur from East Dubuque over the Mississippi River Bridge—these could well use such independent motor cars; unless, indeed, electric power at satisfactory rates can be purchased of the neighboring electric companies.

"There is another field, not very wide it is true, but a profitable field which the independent motor car may enjoy with freedom from competition. The writer expects to see the present private cars of our millionaires displaced by the independent motor car, which can be made as comfortable and luxurious as any of the Pullmans now in service. Their owners may go anywhere that standard gage tracks lead to, regardless of limitations to locomotives or to electric cars.

"As to prospective interurban roads which are promoted with the view to using the gasoline or other types of independent motor, it is highly desirable to go slow and investigate. Broadly speaking, if a prospective road is to depend for revenue only on its passenger and light express traffic, and the business only warrants 1½ or more hours headway between cars, it becomes very much of a question whether or not the road will pay or ought to be built at all.

"But this brings us into the realm of interurban railway economics, concerning which much less even than railway engineering it is not well to generalize. Each individual proposition should be independently examined and passed upon by a competent engineer, who should determine the equipment best fitted for it.

"In conclusion, the writer believes that the independent motor car will prove a useful transportation medium. Its field will be distinct from that served by the standard electric system. The likelihood of the independent motor cars becoming serious competitors of the electric cars is quite remote. Reduction in operating cost of the independent car must come about through cheaper fuel and smaller labor expense. As we all know, the price of gasoline is constantly increasing, due to the diminishing supply of the crude oil from which it is made. Kerosene engines and alcohol engines are frequently spoken of, but as yet can not compete with the gasoline engines. The reduction in labor expense is not very promising. Advances and improvement in the art of motor car construction will undoubtedly be made, but at the same time it must be borne in mind that the electric system will by no means stand still, and if its future progress be judged by that of the past, it will undoubtedly become the pre-eminent transportation medium."

THE ELASTIC LIMIT OF METALS.

THE DETERMINATION OF THE ELASTIC LIMIT OF A METAL BY RECORDING THE VARIATION IN ELECTRICAL RESISTANCE.

M. Guillery—Revue de Métallurgie.

THE determination of the elastic limit of a metal used in construction is admittedly a matter of great importance, and everything which leads to its precise and accurate measurement is to be welcomed.

Briefly, the elastic limit has been defined as that point beyond which strain ceases to be proportional to stress. Such a limit is easier to define than to determine, and in practice none of the methods employed in connection with the commercial testing of materials is wholly satisfactory. When the testing machine is equipped with a reliable recorder the curve rarely shows a distinct point at which the straight line ceases and the rapid curvature of yield begins; and the observer must depend to a certain extent upon his judgment. The determination of the yield point by observing the drop of the beam of the testing machine is a method often used, and with a careful and conscientious experimenter this plan may be employed, but it cannot be said to have claims to scientific accuracy. Some careful observers depend upon their own measurement of the elongation of the test piece by use of dividers, noting the increase in length for successive uniform increases in load, and thus discovering the point at which the elongation begins to increase more rapidly than the stress.

Recently a new method has been proposed, that of recording the variations in the electrical resistance of the test piece as the load in the testing machine is increased, and while this method cannot yet be said to be fully developed, it appears to have possibilities which entitle it to respectful consideration. In a recent issue of the *Revue de Métallurgie* there is given an account of the method by M. Guillery together with the results of a number of tests made by him at Denain. These are also discussed by M. Le Chatelier, in comparison with tests made upon companion test pieces at the laboratory of the *Ponts-et-Chaussées* by M. Mesnager so that it will be seen that the method is in thoroughly competent hands.

The general arrangement of the apparatus is clearly shown by M. Guillery. The test piece is held in the clamps of the testing machine in such a manner that it is insulated by layers of ebonite or fibre. A current of 4 or 5 volts pressure and 25 to 30 amperes per square centimetre of section of test piece, is furnished by a storage battery, this passing partly through the test bar and partly through a compensating resistance. By means of soldered contacts with the extremities of the test bar, a shunt is connected with a Carpentier ballistic galvanometer. Another shunt circuit, taken from the compensating resistance is passed through the galvanometer in the inverse direction, and as this latter may be regulated it is possible to neutralize the deflection due to the first current, and thus bring the reflected ray of light from the galvanometer mirror to zero on the scale at the beginning of the experiment. The subsequent deflections of the galvanometer will then be due to the variations in the electrical resistance of the test piece, and these variations may be recorded photographically, or mechanically. Since the plate upon which the record is made can be moved by a connection with the sliding weight upon the beam of the testing machine, a curve may be traced, which, by suitable calibration will give the stress-strain diagram. M. Guillery examines analytically the relation between the reduction in section and the increase in electrical resistance, showing the nature of the curve, and the fact that the change of curvature at the elastic limit should be clearly defined. A number of reproductions of actual curves indicate that the theoretical considerations are closely reproduced in practice, the change in the direction of curvature being sharply indicated at the point where the strain, or elongation, was no longer directly proportional to the stress or load. It only remains to be assured of the correctness of the calibration to permit the numerical values to be obtained.

A number of test pieces of soft, medium, and hard steel were selected by M. Le Chatelier in duplicate, one set being delivered to M. Guillery at Denain, and the other to M. Mesnager at the testing laboratory of the *Ponts-et-Chaussées*, each series of test pieces having been subjected to similar heat treatment, including tempering, annealing, and raising to a white welding heat. The test diagrams obtained from a number of these specimens are reproduced in the paper and the ultimate resistances, elongations, and elastic limits deduced.

In commenting on these tests, in comparison with those shown by the Mesnager automatic recorder upon the companion test pieces at the *Ponts-et-Chaussées*, M. Le Chatelier notes a constant difference, which he attributes to a difference in the graduation of the two machines. He also rejects certain of the results obtained by M Guillery as having been obtained beyond the proper scale limits of the recording galvanometer, and finds the remaining results fairly comparable.

It has not been fully settled, however, that the increase in the electrical resistance of a test is wholly due to the reduction in cross section, and it is altogether possible that certain chemical changes also occur which may influence the electrical resistance. These and similar points remain for subsequent investigation, and it is altogether possible that certain corrections may need to be made before precise and reliable numerical values may be obtained by the electrical method. The simplicity of the apparatus, however, and its ready applicability to testing machines of various patterns, renders it worthy of notice; and, in the hands of competent scientific investigators it may result in the acquisition of valuable information concerning important materials of construction.

IMPROVEMENTS IN SPACE TELEGRAPHY.

PROGRESS IN THE REGULATION AND DIRECTION OF ELECTRIC WAVE TELEGRAPHY BY THE CONTROL OF PHASE DIFFERENCES.

By Dr. F. Braun—The Electrician.

EVER since the first practical experiments with the transmission of intelligence through space by the means of electric waves, the problem of limiting the reception of communication to selected points has been under investigation. The fact that the waves from the transmitter were emitted in all directions, to be picked up and recorded by any one anywhere who might set up a receiver, seemed to be a material objection to any system of space telegraphy, and the importance of controlling in some way the signals sent out from a given station has been made evident by the untiring efforts of the leading experimenters to accomplish such control.

The first method which naturally suggested itself was to use different wavelengths for different transmitting stations, and efforts were made to devise receivers which should be sensitive to waves of but a single length, failing to respond to messages from any transmitter but the one to which they were tuned. This syntonic method has been carried to a certain practical stage of operation, so that tuned space telegraphy is now an accomplished fact, within certain limitations, while at the same time the efforts which have produced these results have also extended the distances to which messages may be sent. The syntonic method, however, does nothing to prevent the great waste of energy involved in sending waves in all directions, when they are needed in but a single line.

This leads to the second method which has been, and still is under development, that of directing the energy in the direction only in which it is desired that the messages shall be sent, and it is this accomplishment of directed space telegraphy which bids fair to become a most important line of development.

In recent issues of the *Electrician* appear papers by Professor Dr. F. Braun, who has under development important experiments in this line of research, and although the account of his work involves much mathematical study, not available for review in these columns, it may be found practicable to give some general idea of the degree of success which has thus far been attained. The whole subject is also discussed editorially in the *Electrician* in a manner which adds materially to the paper by Dr. Braun, and places the present state of the art clearly upon the record.

It is generally understood that the waves in space telegraphy are emitted from antennæ, or vertical wires erected into the air, and with a single antenna the waves appear to be dispatched in all directions. In the various attempts to direct the waves it has been found that the use of more than one wire gave encouraging results. It was not until the idea of using non-vertical wires was taken up, however, that the true line of investigation was pointed out, and the pioneer work of von Sigsfeld, Strecker, Slaby, and DeForest, as well as the studies of Marconi, led to the gradual development of the method which has been amplified by the work of Dr. Braun.

It is well known that if a source of light is placed at the focus of a parabolic mirror, the rays striking all points of the surface of the mirror will be reflected in lines parallel to the axis of the parabola. This fact, originally due to Huyghens, is the basis of all reflecting projecting apparatus for light waves, and it naturally contains the germ of a suggestion for the direction of electric waves. In attempting to apply this principle to the direction of energy in space telegraphy, DeForest erected a number of equal vertical wires on the arc of a parabola, at the focus of which was the equal vertical sender. This arrangement involved the setting of each vertical wire on the parabolic arc into electrical oscillation, these oscillations being again dispatched from the several wires, causing a proportion of the total radiation to be reflected along the axis of the parabola, in a manner analogous to the reflection of light from a parabolic mirror. The difficulty with this method lay in the fact that the difference in distance of the various wires from the focal

sender causes differences of the oscillations on the different wires, both in amplitude and phase.

This difficulty has been overcome by Dr. Braun in a most effective manner by setting up independent oscillations of the proper frequency, amplitude, and phase on each of the wires, this generating plane waves of multiplied vigor travelling along the axis of the parabola.

"The advantages which accrue from the introduction of independent sources of radiation are obvious:—

"(*a*) One is not bound to the parabola form, as in the case of the experiment with electric images. In that case the focal distance must be nearly equal to one-quarter the wave-length, because in the cases which are possible in practice the direct radiation is not negligible compared with the reflected radiation. If one were to work with wave-lengths such as are customary in wireless telegraphy (say, waves of 160 metres length), the aperture of the mirror, measured at the focus, would have to be of the same magnitude. But even a structure of a length of one whole wave would not act in accordance with the laws of geometrical optics. Hence one arrives at dimensions which are unpractically large. On the other hand, the experiments with wave-lengths of 120 metres, which are described below, were carried out with three transmitting wires arranged in a parabola of a total length of 3 metres only.

"(*b*) Obviously, the total radiation from several wires is larger than that from a single transmitter.

"The disadvantages are: Generally speaking, energy is also radiated at the back and the sides of the mirror. The geometrical disposition leads to certain inconveniences in practice and conduces to energy losses.

"Many questions arise which cannot be answered *a priori* but can only be determined by experiment. Among them are: (*a*) If the distance from a source of radiation is only a fraction of a wave-length, one cannot make calculations with the velocity of propagation that the wave assumes at a greater distance. But as this applies to each of the several transmitters, it is to be expected that the effect on the field strength at a very distant point is neutralised just as it is eliminated from the calculations which are based on a constant velocity of propagation at longer distances. (*b*) A wave, due to the action of the other transmitters, is generally superposed on the wave impressed directly on the wire. This superposed wave is out of phase with the wave proper, because the phases in the other wires differ from the phase of the wave in the wire we are considering, and also because of the different intervening distances. These two waves produce a resultant which differs both in amplitude and phase from the impressed wave. Since the waves do not start simultaneously, there must be a complicated oscillation during the starting period, and the stationary condition will only be established gradually."

Dr. Braun gives a mathematical analysis of the manner in which the oscillations are established, taking into account the inductional and damping effects, deriving equations from which the operative conditions may be computed.

"The following is evident, however, without going into the problem mathematically: In coupled systems—which alone are used in practice—the currents in the wires start with small values and increase but gradually. For this reason, the complex initial oscillations in a wire, to which attention was directed above, take place at a time when the action at the far end has not yet attained an appreciable value. Their influence is hardly observed at the phase-measuring apparatus, and the inconvenience can, therefore, be circumvented by measuring and regulating the phase differences after the transmitting wires have been connected up.

"(*c*) So far it has been assumed that there is only one oscillation in each transmitting wire. This, however, only holds good if the coupling is of the loosest. In the actual experiments, there were two oscillations in each wire. The stronger of the two had a wave-length of 120 metres and existed in every wire. It was accompanied by a weaker wave of greater wave-length. But even if each system, oscillating independently, possessed a single oscillation only, the mutual influence of the transmitting wires would introduce a further coupling. This was actually observed when the wires were near one an-

other. For this reason the distances between the wires were kept large.

"(*d*) Such mutual effects are also caused by the leads to the transmitting wires and by the connecting wires—with end capacities—which were relatively near to each other.

"The experiments were made on the following lines:—

"(*a*) To determine, by integrating instruments, the mean field strength at various positions relatively to the air wires.

"(*b*) Assuming these observations to confirm the calculations, to investigate whether the methods are of practical use in connection with the detectors employed in wireless telegraphy. This was necessary because it was thought conceivable that irregularities in the action of the air wires might cause the usual detectors to respond, even if the mean field at the point of observation were nil or very weak.

"In view of the complicated nature of the problem, it was thought best to commence with the simple case of three transmitting wires arranged at the corners of an equilateral triangle. With symmetrical excitation, this also represented the simplest case of the parabola arrangement. A further advantage of this arrangement relates to the possibility of rotating the parabola axis in two steps of 120 deg. each, by interchanging the electric conditions of the air wires. Besides, intermediate directions of the maximum field may be obtained by altering the amplitudes and the phase relations.

Experimental investigations were carried out at Strasburg in accordance with the theoretical deductions, details of which are given at length in the paper of Dr. Braun. The results confirmed in great measure the original conclusions, checking the mathematical computations to a remarkable degree. The experiments included investigations of the field in the case of a fixed phase difference, and in the case of an alteration of the phase difference. The results are tabulated in the paper, and confirm the theoretical deductions, indicating that the directions of the waves may be closely controlled.

STEAM-BOILER PERFORMANCE.

PRINCIPLES INVOLVED IN THE INCREASE OF EFFICIENCY AND OUTPUT OF STEAM BOILERS IN POWER STATIONS.

G. Wilkinson—Municipal Electrical Association.

IN the course of the development of the modern power house many improvements and modifications have been made over the power-generating methods derived from mill and factory practice. Some of these modifications form the subjects of a valuable paper presented before the Incorporated Municipal Electrical Association by Mr. G. Wilkinson, and published in full in the *Electrical Engineer*, and we note especially those relating to the possibilities for improvement in steam-boiler efficiency and output.

Mr. Wilkinson points out that there has been a continual tendency in the engine room to decrease the size of units, while at the same time to increase the output. Thus the use of high-speed engines, and especially of steam turbines, has made it possible to install three or four times the amount of power in a given space than was possible 10 years ago. A similar development has taken place in regard to the electrical machinery, so that many older plants have been replaced by equipments of much greater generating capacity in the same space as that formerly occupied by the lower capacity outfit.

Similar progress has not been made in the steam-generating portion of power-house equipment, however, and Mr. Wilkinson believes that there is room for improvement in the design and operation of the boiler house along the lines which have proved satisfactory and successful in the engine room. Especially if the desirable "unit" system is adopted and maintained is it important that the space, in running feet, occupied by the boilers, should be about the same as that required for the engines and balance of the machinery, otherwise a satisfactory arrangement of floor space, piping, etc., becomes impracticable. This demand has been partially

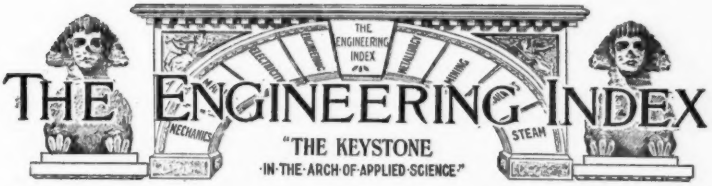
met by placing the boilers in double-deck, one above the other, but this system is expensive to install and inconvenient to operate, besides introducing complications in piping, etc. A more scientific remedy is to increase the size and steaming capacity of the boilers, so that the supply of steam per running foot shall be equal to the demand from the engines occupying the same space.

The question is thus resolved into an increase in the rate of transmission of heat from the fuel in the furnace to the water in the boiler, not only as the average demand may be, but as it may be called for by the emergencies of operation. This also includes an efficiency which shall not be lower, and may be higher, than is now attained by boilers operated at a lower steaming rate.

In considering the method by which this desirable result may be accomplished, Mr. Wilkinson calls attention to the fact that the true function of a steam boiler is to make steam, and not to warm water. Since the transmission of heat through the boiler plates is much more rapid at those points where evaporation is actually taking place than in portions at which water is being raised to the temperature of evaporation, it is most important that the feed water be introduced as nearly as possible at the temperature due to the pressure of the steam in the boiler. If the water is thus raised to the actual temperature of evaporation before it enters the boiler at all the whole of the heating surface of the boiler will be converted into actual evaporating surface. Since much more heat is absorbed in the conversion of water into steam than is required to raise the water to the evaporating temperature it follows that the absorption of heat is much more rapid at those portions of the boiler surface where evaporation is taking place than elsewhere, and much more intense firing can be employed without danger of injury to the metal. If, therefore, the whole body of the water in a boiler can be maintained at the temperature of evaporation, the maximum absorption of heat will take place over the entire heating surface, and consequently a maximum intensity of firing may be maintained with efficiency. So far as danger to the heating surfaces is concerned, Mr. Wilkinson shows that the latest scientific researches have demonstrated that no such danger exists, provided the heating surfaces are kept clean and the internal surfaces free from scale and grease. The experiments of Hirsch show that, with sound and clean plates, rates of evaporation up to 75 pounds of water per square foot per hour may be maintained without injury, and this view is confirmed by other investigators. Since present practice shows rates of but 2½ to 7 pounds of water per square foot per hour it is evident that there is here much room for improvement in stationary practice. That higher rates of evaporation are entirely practicable is shown by results obtained in locomotives. Thus at the tests of the Pennsylvania Railroad Company at the St. Louis exposition, total rates as high as 16 pounds per square foot of heating surface per hour were obtained, and much higher rates than this are maintained in the fire-box, experiments on the Northern Railway of France having shown fire-box rates of more than 40 pounds per square foot. Certainly rates of 10 to 20 pounds should be possible in regular practice with suitably designed boilers and accessories.

The question practically settles itself down to methods of heating the feed water to the steam temperature. Mr. Wilkinson believes that this is best obtained by the use of live-steam heaters, and advocates the use of some form of thermal storage, similar to that devised by Mr. Druitt Halpin, possibly improved so as to secure a continuous operation, maintaining a supply of highly heated feed water available at all times.

Mr. Wilkinson discusses the experiments of Anderson, Dales, Hamilton, and others, for which reference must be made to the original paper, but we may here quote the conclusions of Hamilton: viz., that live-steam heaters do save fuel; that economisers show a greater saving than has been accounted for; that evaporating water absorbs heat more rapidly than water which is being only heated; that the rate at which heat passes through a plate depends upon the difference of temperature on the two sides of the plate; and, that evaporation always cools the surface upon which it takes place.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Arch Construction of the Connecticut Ave. Bridge, Washington. Illustrated description of the method of construction used for the bridge across Rock Creek. 1200 w. Eng Rec—June 2, 1906. No. 77071.

Empirical Formulas for Reinforced Arches. Daniel B. Luten. Discusses a method of empirical design that will enable a designer to lay off all the details of the section for an 80 ft. span in less than an hour's time, yet with great accuracy and efficiency. Ills. 3300 w. Eng Rec—June 28, 1906. No. 77532.

The Bridges over the Iller at Kempten, Allgau, Bavaria (Die Illerbrücken bei Kempten im Allgau). H. Colberg. Describing the construction of two concrete arches of 64.5 metres span, hinged at the crown and spinnings. Illustrations of the centerings and the work in progress are

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given. Three articles, 4000 w. Deutsche Bauzeitung—April 21, 28, May 2, 1906. No. 77662 each B.

Two Austrian Reinforced Concrete Arch Bridges. Gives two illustrations of ribbed arches with open spandrels, with brief descriptions. 500 w. Eng News—June 21, 1906. No. 77410.

Chicago.

A Thirty-three Track Bridge at Chicago. Describes an unusual bridge across 51st St., its constructive details, and careful waterproofing. 1200 w. Eng Rec—June 16, 1906. No. 77337.

Diagram.

A Diagram for Bridge Laterals. O. W. Childs. Gives a diagram designed to enable one to read off the proper size of lateral rod for any panel of any length and roadway within the limits for which the diagram is constructed, explaining its use. 400 w. Eng News—June 21,1906. No. 77414.

Drawbridge.

A Temporary Wooden Drawbridge. Illustrates and describes a bridge built over the Chicago River at Chicago, to carry highway and street railway traffic during the building of permanent bascule bridges. 1200 w. Eng Rec—June 9, 1906. No. 77236.

Newcastle.

The New Railway Bridge at Newcastle. The new high-level bridge of the North-Eastern Ry. Co., over the River Tyne, connecting Gateshead and Newcastle, is illustrated and described. 2500 w. Engr, Lond—May 25, 1906. Serial. 1st part. No. 77147 A.

New York.

The New Manhattan Bridge. W. S. Crandall. Illustrated description of the fourth bridge to be built across the East Island. 1800 w. Munic Eng—June, 1906. No. 77303 C.

Prague.

A Critical Study of the Competitive Designs for a Bridge over the Moldau at Prague (Kritische Betrachtungen über den Wettbewerb für eine Moldaubrücke beim Rudolfinum in Prag). W. Plenkner. With sketches of the seven designs submitted, computations of the stresses, and a comparison of estimated costs. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 19,1906. No. 77620 D.

Quebec.

The Progress of the Quebec Bridge. An illustrated report of the work on this bridge across the St. Lawrence River. 3000 w. Eng Rec—June 23, 1906. No. 77430.

Reinforced Concrete.

The Chauderon-Montbenon Reinforced Concrete Bridge at Lausanne (Die Beton-Eisen Brücke Chauderon-Montbenon in Lausanne). J. Melan. Full details of the high-level viaduct recently constructed at Lausanne, with strain sheets for the arches, and details of the centerings. 5000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—June 1, 1906. No. 77616 D.

Short Spans.

Short-Span Bridges on the Baltimore & Ohio Railroad. Illustrates and describes types of solid floor bridges, in which the loads are chiefly carried by steel beams and girders and the latter are entirely enclosed in concrete integral with the floor slab. 1500 w. Eng Rec—June 16, 1906. No. 77342.

Stresses.

A New Method of Calculating Bridge Stresses by Means of End Shears. W. T. Curtis. Discusses the table of Mr. Gibson in its new form, and commends it as a practical aid in the calculation of stresses in railroad bridges. General discussion. 3000 w. Jour W Soc of Engrs —June, 1906. No. 77506 D.

Viaduct.

The Sixth Street Viaduct at Kansas City. A steel highway viaduct, costing about $2,500,000, is briefly described. Ills. 2000 w. Eng Rec—June 2, 1906. No. 77076.

Viaduct Over the River Barrow Near Waterford. Begins an illustrated description of the largest viaduct in Ireland, its design and construction. 4000 w. Engng —May 25, 1906. Serial. 1st part. No. 77137 A.

CONSTRUCTION.

Beams.

A Floor-Beam Scale in Parallel Co-ordinates. Lucien E. Picolet. Gives a scale for determining the size of steel I beams for floors for any given span and spacing. 1200 w. Eng New—May 31, 1906. No. 77044.

Buildings.

The King's Sanatorium at Midhurst. Describes the engineering features of this recently built sanatorium, built for the special treatment of sufferers from tubercular disease. 1800 w . Engr, Lond—June 15, 1906. No. 77483 A.

The New Soap Factory Building of Armour & Co. at Chicago. Illustrated description, and report of tests of the reinforced concrete floor system of a factory carrying very heavy loads and subjected to the operation of heavy machinery on the upper floors. 2800 w. Eng Rec—June 2, 1906. No. 77075.

Earthquake.

Burnt Clay Construction at San Francisco. Charles H. Alden, Jr. An illustrated account of the condition of materials subjected to the earthquake and fire. 3000 w. Br Build—May, 1906. No. 77180 D.

Earthquakes and Earthquake-Proof Buildings. William F. Scott. Considers

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the construction of such buildings should be the same as an ocean liner, but as that is impossible, suggests a compromise. 1000 w. Can Archt & Build—May, 1906. No. 77032 C.

Observations of Distant Earthquakes. F. Omori. An explanation of observations made in Tokio, of the San Francisco earthquake, and the determination of the locality and time of the shock. Also editorial. 4000 w. Min & Sci Pr—June 16, 1906. No. 77459.

Our Greatest Earthquakes. Myron Leslie Fuller. Principally an illustrated description of the earthquakes of 1811 and 1812 in the New Madrir region, on the Mississippi River. 4000 w. Pop Sci M—July, 1906. No. 77497 C.

Report of the State Earthquake Commission. Chief part of the report of the Commission appointed to investigate the earthquake which led to the great conflagration at San Francisco. Ills. 3300 w. Min & Sci Pro—June 16, 1906. No. 77460.

Steel Structures in the San Francisco Disaster. George Simpson. A report of the effects of fire, dynamite and earthquake upon the skyscraper. Ills. 6000 w. Ir Age—June 7, 1906. No. 77151.

The Destructive Extent of the San Francisco Earthquake of 1906. Charles Derleth, Jr. Remarks on the evidences of instability of the earth's crust, especially in the San Francisco region, faults, displacements, effects of geological structure, etc., with illustrated description of the destruction wrought at various points by the recent earthquake. 5500 w. Eng News—June 28, 1906. No. 77529.

The Earthquake Explained. A. S. Cooper. Map and explanation of the faults and step-faults of this region. 700 w. Min & Sci Pr—June 16, 1906. No. 77461.

The Effects of Earthquake and Fire on Modern Steel Buildings. Clarence Heller. Personal observations of the San Francisco disaster, and the lessons in building construction there brought out. 3500 w. Engineering Magazine—July, 1906. No. 77684 B.

The Geological Prelude to the San Francisco Earthquake. George H. Ashley. A résumé of the recent geologic history of the San Francisco peninsula and the observed evidence upon which the statement of that history is based. 2000 w. Pop Sci M—July, 1906. No. 77496 C.

The Great Fire in San Francisco. W. G. Mitchell. A report of the effect of the fire upon the buildings, and the material that best withstood the severe trial. 1800 w. Am Archt—June 2, 1906. No. 77083.

The Probable Cause of the San Francisco Earthquake. Frederick L. Ransome. An explanation of the geology of the region and the rock movements causing the earthquake. Map. 1700 w. Min & Sci Pr—June 16, 1906. No. 77458.

The Structural, Municipal and Sanitary Aspects of the Central Californian Catastrophe. Charles Gilman Hyde. An illustrated article presenting a statement of conditions produced by earthquake and fire, and conclusions drawn from them. 3700 w. Eng Rec—June 2, 1906. Serial. 1st part. No. 77069.

Earth Slides.

The Clay Slide at the Boone Viaduct, Boone, Iowa. A. W. Merrick. An account of this slip or slide and the methods of drainage for remedying the trouble. Also a paper by E. E. R. Tratman on "Foreign Railway Construction on Sliding Ground." Ills. 7500 w. Jour W Soc of Engrs—June, 1906. No. 77507 D.

Excavation.

See Civil Engineering, Waterways.

Foundations.

A New System of Foundations (Ueber eine Neue Gründungart). Fritz Hromaka. A description of the Dulac system, in which holes made by a falling pointed ram are filled with concrete. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—May 26, 1906. No. 77621 D.

Mechanical Compression of the Ground in the Construction of Foundations. Emile Guarini. Illustrates and describes a method discussed in a lecture by M. Ducloux, before the Société Belge d'Ingenieurs et Industriels. It consists in compressing the ground by treating it with concrete so as to compress it laterally and depthwise. 2300 w. Sci Am—June 9, 1906. No. 77253.

Reinforced Concrete.

A British Investigation of Reinforced Concrete. Statement issued by a joint committee representing the Royal Inst. of British Archts., the District-Surveyors' Assn., the Inst. of Builders, the Assn. of Munic. & Co. Engrs, and the War Office. 1800 w. Eng Rec—June 16, 1906. No. 77341.

Design of a Long Reinforced Concrete Girder. Frank H. Constant. Description and method of computation employed in the design of two 60 ft. reinforced concrete girders supporting a roof over a ball-room. 3500 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77514 N.

Building Code for Reinforced Concrete. Section 110 from the "Building Code" recommended by the National Board of Fire Underwriters, which gives a standard for concrete construction. 2000 w. Am Archt—June 9, 1906. No. 77179.

"Ferro-Concrete." Sven Bylander. Read before the Soc. of Engrs. An illus-

trated article considering the best known systems of reinforced-concrete construction, and the methods of approximately ascertaining the stresses. 5500 w. Ir & Coal Trds Rev—May 25, 1906. No. 77149 A.

General Notes on the Theory of Reinforced Concrete Design. R. V. Engstrom. Discusses the interesting phases of this new material, the stresses, the relation of stresses and dimensions, etc. Ills. 2500 w. Technograph—No. 20. No. 77165 D.

Reducing the Cost of Centering and Form in Reinforced Concrete Building Work. Editorial remarks on economical form work. 1400 w. Eng News—June 14, 1906. No. 77439.

Reinforced Concrete and Fireproof Construction in the San Francisco Disaster. Maurice C. Couchot. A report of the condition of these buildings after the earthquake and fire, and suggestions for fireproof construction. 1000 w. Eng News—June 7, 1906. No. 77242.

Reinforced Concrete Bar. A steel bar for reinforced concrete, known as the "Johnson," is illustrated and described, and tests made are reported. Illustrations of practical applications are given. 1600 w. Engr, Lond—June 8, 1906. No. 77391 A.

Reinforced Concrete. Robert A. Cummings. Briefly considers the reasons for steel being embedded in concrete, the materials which compose concrete, the proportions, mixing, etc., methods of erection and applications. General discussion. 10000 w. Pro Ry Club of Pittsburg—Feb., 1906. No. 77292 C.

Roads.

A Road Drag for Improving Earth Roads. Abstract of Bul. No. 1 of the Illinois State Highway Commission, describing the good results and methods of dragging to improve roads, and the simple drags used. 1200 w. Eng News—June 14, 1906. No. 77442.

Laboratory Tests for Road Metals. William R. Hoag. Introductory review of early methods of road construction, and description of machines for determining the comparative value of different materials used in highway construction. 2500 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77512 N.

The Development of the Test for the Cementing Value of Road Material. Allerton S. Cushman. Read before the Am. Soc. for Test. Mat. An account of the attempts made to test the cementing value, and the results. 2000 w. Eng Rec—June 23, 1906. No. 77429.

The Adhesion of Concrete to Steel as Affected by the Quantity of Water Used in Mixing. R. Feret. An account of experiments by the writer, with tabulated results, and notes. 2000 w. Cement—May, 1906. No. 77033 C.

Roofs.

Short Cuts in the Design of Roof Howe Trusses. Benjamin E. Winslow. Gives the results of an investigation to see if it is possible to design a few standard Howe trusses for ordinary flat gravel roofs. Diagrams and tables. 1200 w. Technograph—No. 20. No. 77164 D.

Trusses.

Two-Hinged Arch Trusses for the New Livestock Pavilion, Chicago. Gives sketch plan and diagrams of this new hall for exhibition uses, describing the features of special interest. 1300 w. Eng News—June 28, 1906. No. 77530.

Tunnels.

Driving a Tunnel. An illustrated account of ancient and modern methods of constructing tunnels. 2000 w. Ry & Loc Engng—June, 1906. No. 77101 C.

Handling Spoil from City Tunnel Workings. Illustrated description of a telpher hoist equipment and a new type of quick dumping skip used in connection with tunnel work in New York City. The operation is entirely noiseless, which is of importance as the work goes on night and day in the residence district. 2000 w. Eng Rec—June 16, 1906. No. 77345.

Grade Corrections in the Battery Tunnel, New York. Brief description of the tunnel under construction to connect the subway systems in the Boroughs of Manhattan and Brooklyn, with an explanation of the irregularities and their causes, and a discussion of proposed methods of reconstruction. 2400 w. Eng Rec—June 2, 1906. No. 77070.

Notes on Great Tunnels. Lewis M. Haupt. On the recent development in tunnel construction, giving a brief chronological statement of the statistics and time of construction of the several long railroad tunnels, and other important structures. Ills. 3500 w. Jour Fr Inst—June, 1906. No. 77322 D.

Report on the Defects of the Brooklyn Tunnels of the New York Rapid Transit Ry. Gives the report of George S. Rice. 2500 w. Eng News—May 31, 1906. No. 77043.

Steel Cofferdam for a Hudson River Tunnel Shaft. Illustrates and describes work in connection with the construction of the elevator shaft to the Hudson tunnel between Jersey City and Manhattan. 900 w. Eng Rec—June 2, 1906. No. 77073.

The Construction of the Simplon Tunnel (Der Bau des Simplon tunnels). C. J. Wagner. A general review of the whole Simplon-tunnel project, with a tabular view of the execution of the work, to its completion. 8000 w. Oesterr

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Wochenschr f d Oeffent Baudienst—June 2, 1906. No. 77623 D.

The Construction of the Simplon Tunnel (Die Bauarbeiten am Simplon tunnel). Dr. K. Pressel. A very full account of the building of the Simplon tunnel, with topographical map, and detailed plans, sections, and records of the work. Serial. Part I. 2500 w. 1 Plate. Schweiz Bauzeitung—May 26, 1906. No. 77619 B.

The Piercing of the North End of the Karawanka Tunnel (Der Sohlstollenvortrieb bei dem Bau des Karawankentunnels, Nord.) Jos. Fischer. Describing the piercing of the Karawanken mountains by the tunnel to connect Trieste with the interior of Austria-Hungary, including the results of the use of electric rock drills. 4500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—June 9, 1906. No. 77624 D.

The Piercing of the Eastern Alps (Il Traforo delle Alpi Orientali). Emilio Gerli. A discussion of the relative advantages of the Splügen and the Greina routes. Three articles. 7500 w. Monitore Tecnico—April 30, May 10, 20, 1906. No. 77663 each D.

Underpinning.

Underpinning the Criterion Hotel, New York. The reconstruction of this building to adapt it for commercial uses, made necessary some interesting underpinning and heavy shoring, which is illustrated and described. 1200 w. Eng Rec—June 2, 1906. No. 77077.

MATERIALS OF CONSTRUCTION.

Brick.

Tests of the Strength and Fireproof Qualities of Sand-Lime Brick. Ira H. Woolson. Reports a full series of tests made upon 15 varieties of common clay bricks, and a description of the tests applied to sand-lime bricks with the results. 5000 w. Eng News—June 14, 1906. .No. 77440.

The Rattling Test as a Safe Method of Disclosing the Permissible Absorption of Paving Brick. Prof. Edward Orton, Jr. Read before the Nat. Brick Mfrs.' Assn. The present number discusses the standing of the rattling, absorption and other tests, reports investigations made, and tests carried out. 3800 w. Brick—June, 1906. Serial. 1st part. No. 77162.

The Strength of Brickwork. Editorial review of the Report on Brickwork Tests, conducted by a committee of the Royal Institute of British Architects. 2500 w. Engng—June 15, 1906. No. 77487 A.

Cement Blocks.

Cement Block Manufacture. S. B. Newberry. From a paper before the Nat. Assn. of Cement Users. Considers the two systems of block making, block machines, their hardening and storage, cost, etc. 2000 w. Munic Engng—June, 1906. No. 77302 C.

Cement.

A New Fine Grinding Machine for Cement Mills. Richard K. Meade. Illustrates and describes a new mill which is giving good results. 2200 w. Eng News—June 21, 1906. No. 77411.

Cement for Building Construction. Report of a special committee of the National Fire Protection Association. Concrete blocks, reinforced concrete, and reinforced concrete beams are considered. 4000 w. Eng Rec—June 9, 1906. No. 77239.

Cement Materials and Industry of the United States. Edwin C. Eckel. Abstract from Bul. U. S. Geol. Survey. Defines the classes of hydraulic cements, discussing the materials and manufacture. 5700 w. Sci Am Sup—June 2, 1906. No. 77047.

Cement on the Farm. E. A. Trego. Remarks on the adaptability of the material to farm needs, describing a model farm on Long Island. 1600 w. Cement Age—June, 1906. No. 77122.

The Decomposition of Cements in Sea Water. H. Le Chatelier. From the Pro. of the Int. Assn. of Test. Mat. A sketch of laboratory experiments made by the writer. 2000 w. Munic Engng—June, 1906. No. 77305 C.

The Formation of Rings in Cement Kilns. Carleton Ellis. Brief discussion of the causes of these aggregations which frequently encrust the internal walls of a rotary cement kiln and prevent the free passage of flames and gases. 1200 w. Eng Rec—June 16, 1906. No. 77343.

Concrete.

Concrete Aggregates. Sanford E. Thompson. Gives the general principles that should be followed in the selection of sand and stone for mortar and concrete, and describes the method of testing aggregates and determining proportions. 4000 w. Cement—May, 1906. No. 77034 C.

Concrete Work in Boston. E. S. Larned. Descriptions of some of the buildings and structures which have recently been completed or are being built. Ills. 5000 w. Cement Age—June, 1906. No. 77121.

Investigation of the Thermal Conductivity of Concrete and the Effect of Heat Upon Its Strength and Elastic Properties. Ira H. Woolson. Read before the Am. Soc. of Test Materials. A record of experiments on the conductivity, strength and elasticity of concrete. 3000 w. Eng News—June 28, 1906. No. 77533.

Some Examples of Concrete Mixing and Delivery Plant. William G. Fargo. Abstract of a paper read before the Mich. Engng. Soc. Illustrates and describes several types of concrete plant suitable for moderately heavy work, treating more especially the handling to and from the

We supply copies of these articles. See page 709.

mixer. 2500 w. Eng News—May 31, 1906. No. 77041.

The Comparative Resistance to Fire of Stone Concrete and Cinder Concrete. Describes two tests made by the British Fire Prevention Committee demonstrating the superiority of cinder concrete. 1200 w. Eng News—May 31, 1906. No. 77039.

The Early Use of Concrete. Extracts from a paper by Thomas Potter in *The Builders' Jour.* Reviews some very early uses of this material. 3500 w. Am Archt —June 23, 1906. No. 77424.

Gypsum.

Gypsum—A Much Misunderstood Material. Robert Grimshaw. Information of interest concerning gypsum and its use. 1800 w. Sci Am Sup—June 23, 1906. No. 77422.

Piles.

The Manufacture and Use of Concrete Piles. Henry Longcope. Reviews the various methods tried for substituting other material for wooden piles, and the systems for forming concrete piles, and the success attained. 2500 w. Cement—May, 1906. No. 77035 C.

Protective Paints.

Methods of Testing the Protective Power of Paints Used on Metallic Structures. Remarks on rust and the preparations for protecting iron, showing that the durability of a preparation depends on the quality of the linseed oil employed. 700 w. Am Mach—Vol. 29. No. 25. No. 77408.

Timber.

Preservation of Timber. Prof F. H. Bass. Deals with preservation processes, especially considering the creosoting process. Ills. 2000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77511 N.

MEASUREMENT.

Densities.

Use of the Volumetnometer in the Determination of Densities. Floyd R. Watson. Reports an investigation made to test the accuracy of working of the volumetnometer, and to compare it with the Le Chatelier Flask as a means of measuring densities. The substance selected for comparison was Portland cement. 1400 w. Technograph—No. 20. No. 77163 D.

Plotting.

Notes on Plotting Profiles. L. A. Waterbury. A discussion of the methods of constructing profiles and the things that should be shown. 3500 w. Technograph—No. 20. No. 77169 D.

Surveying.

Geodetic and Magnetic Work in the Vicinity of Tananarive (Travaux Géodésiques et Magnétiques aux Environs de Tananarive). Ed Colin. A report on the progress of the official French survey of Madagascar. 1500 w. Comptes Rendus—May 21, 1906. No. 77644 D.

Surveying on the Farm. A. S. Kenyon, in *Jour. of Agri.* (Victoria). Explains the measurement of areas, the prismoidal formula, and other calculations. Diagrams. 4000 w. Sci Am Sup—June 2, 1906. No. 77049.

MUNICIPAL.

Cuba.

Sanitary Conditions in Cuba. Cristino Figuerola Cowan. An illustrated article discussing Havana's great advancement in plumbing and sewerage work. 2000 w. Met Work—June 23, 1906. No. 77425.

Disinfection.

The Municipal Electrolytic Hypochlorite Plant at Poplar. An installation for the purpose of supplying a cheap disinfectant for municipal use, in substitution for disinfectants made from coal tar derivatives, which are slow in action. Ills. 1000 w. Elec Rev, Lond—June 8, 1906. No. 77381 A.

Pavements.

Benefits of Pavements. Ira O. Baker. Read before the Illlinois Clayworkers' Assn. Presents the advantages and disadvantages of pavements, cost, etc. 2000 w. Munic Engng—June, 1906. No. 77304 C.

The Municipal Asphalt Repair Plant at Pittsburg, Pa. Charles Brossmann, Jr. Illustrated description of the plant and its operation. 1200 w. Eng News—May 31, 1906. No. 77038.

Evolution of Street Pavements. George W. Tillson. On the materials formerly, and at present used; the reasons for changes; properties, costs, etc. Ills. 3700 w. Munic Jour & Engr—June 6, 1906. No. 77192.

Washington and Street Paving. An account of the pavements used in the national Capital of the United States, the conditions, average cost and statistics. 2500 w. Munic Jour & Engr—June 6, 1906. No. 77194.

Sewage.

Notes on Sprinkling Filters for Sewage Treatment. George W. Fuller. A résumé of American and foreign experience. 5800 w. Eng Rec—June 23, 1906. No. 77427.

Sewage Disposal at Manchester and Birmingham. Leonard Parker Kinnicutt. An illustrated account of these English plants, one being an example of the contact bed treatment and the other of the percolating filter process. 2500 w. Jour Assn of Engng Soc's—March, 1906. No. 77319 C.

The Intermittent Filtration of Sewage as Practiced in America. Leonard P. Kinnicutt. Address before the Royal Inst. of Public Health, London. Confined to the purification of sewage by intermittent

filtration through prepared sand-beds, as practiced in Massachusetts. 3000 w. Jour Worcester Poly Inst—May, 1906. No. 77155 C.

Sewers.

Reinforced Concrete Sewer at South Bend. Sections showing concrete forms and order of erection, with description. 1500 w. Eng Rec—June 16, 1906. No. 77339.

Some Notes on the Los Angeles Outfall Sewer. W. P. Hardesty. Describes the old and the new sewer and explains the troubles with long inverted siphons. 1600 w. Eng News—June 14, 1906. No. 77435.

Streets.

Street Designing. A. Prescott Folwell. Discusses the principles involved, details, width of roadway and sidewalks, requirements of railways, economy, etc. 3500 w. Munic Jour & Engr—June 6, 1906. No. 77193.

Street Traffic.

Some Observations on the Report of the Royal Commission on London Traffic. Paul Waterhouse. Especially considers the proposed formation of new thoroughfares, the difficulties, and possible solutions. Maps. Discussion. 1200 w. Jour Roy Inst of Brit Archts—May 26, 1906. No. 77370 C.

WATER SUPPLY.

Dam.

The Cross River Dam in the Croton Watershed. An illustrated description of an unusual method of construction employed on the New York water-works. 4800 w. Eng Rec—June 16, 1906. No. 77336.

Filtration.

Filtration. J. N. Chester. Discussion of this subject with especial reference to the South Pittsburg Water Co.'s plant. Ills. 3500 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77301 D.

Ground Water.

The Underground Water Supply of the City of Los Angeles, Cal. W. P. Hardesty. Describes some unusual methods employed in the development of the underflow supply. 3000 w. Eng News—May 31, 1906. No. 77037.

Ozone.

Contributors to the Literature of Ozone (Neues aus der Ozonliterature). A report on the sterilization of water by ozone at Wiesbaden, with a discussion by Dr. Proskauer. 3000 w, 1 plate. Gesundheits-Ingenieur—June 9, 1906. No. 77639 B.

Pure Water.

Life or Death in Pure Country Drinking Water. George Ethelbert Walsh. Shows the dangers found in wells and most water supplies in the country, and considers the best way to secure a safe supply. 2500 w. Archts & Builds' Mag—June, 1906. No. 77178 C.

Sterilization.

Water Sterilization. Dr. Alfred Gradenwitz. Illustrated description of a sterilizing apparatus, showing several types and the variety of applications. 1500 w. Sci Am—June 2, 1906. No. 77051.

Tanks.

The Stresses in the Horizontal Girder of an Elevated Tank. C. E. Day. Gives a study made by the writer of the stresses in a horizontal girder of a tank for a water supply system. 700 w. Eng Rec—June 9, 1906. No. 77238.

WATERWAYS AND HARBORS.

Barcelona.

Extension Works at the Port of Barcelona (Les Agrandissements du Port de Barcelone). François Audion. Describing the extension of the breakwater and the plans for new quays and basins. 3500 w. 1 plate. Génie Civil—May 5, 1906. No. 77610 D.

Canals.

The Sault Ste. Marie Canals. Map and description of the two canals at Sault Ste. Marie. 1800 w. R R Gaz—June 8, 1906. No. 77232.

The Teltow Canal (Der Teltowkanal). Chr. Havestadt. This recently opened waterway connects the Spree with the Havel, passing near Potsdam, Spandau, and Charlottenburg, this rendering it of much commercial importance. Electric traction is used, and details of this, and of the locks and bridges, are given. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—June 2, 9, 1906. No. 77603 each D.

See also Industrial Economy.

Canal Traction.

The Traction Equipment of the Teltow Canal (Die Betriebseinrichtung des Teltowkanals). Erich Block. An exhaustive description of the electric plant designed for the operation of electric traction on the canal connecting the Spree with the Havel. Serial. Part 1. 4000 w. Elektrotech Zeitschr—May 31, 1906. No. 77649 B.

Dock Crane.

A One-Hundred-Ton Derrick Crane for Fitting out Vessels. Illustration, with description, of an interesting crane in use in a Scotch shipyard. 1000 w. Sci Am—June 23, 1906. No. 77420.

Docks.

The Stuyvesant Docks of the Illinois Central R. R. at New Orleans. A modern tidewater freight terminal, occupying a 90-acre site, with a frontage of about a mile on the left bank of the Mississippi River, is illustrated and described. 5000 w. Eng Rec—June 23, 1906. No. 77431.

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Jetty.

A New Ferro-Concrete Coal Jetty on the Thames. Illustrates and describes briefly the main features of a jetty being constructed on the Hennebique system. 900 w. Col Guard—June 8, 1906. No. 77385 A.

Lift-Lock.

The Peterborough Lift-Lock of the Trent Valley Canal. Illustrates and describes this lock on the waterway being constructed to join Georgian Bay with Lake Ontario. It is the largest structure of this character in existence and is built almost exclusively of concrete. 1300 w. Sci Am—July 7, 1906. No. 77826.

Nile.

Remarks on Some Old-Time Engineering. T. C. Mendenhall. An interesting popular account of engineering work and conditions in the valley of the Nile. 6000 w. Jour Worcester Poly Inst—May, 1906. No. 77154 C.

Panama.

Extracts from the Minority Report of the Senate Committee on the Type of the Panama Canal. 11800 w. Eng News—June 7, 1906. No. 77243.

The Panama Canal. Projets of the Board of Consulting Engineers. Gen. H. L. Abbot. A demonstration of the marked advantages of the lock type over the sea-level scheme, a view subsequently accepted by Congress. 4000 w. Engineering Magazine—July, 1906. No. 77681 B.

The Disputed Features of the Panama Canal. A letter from Mr. W. Henry Hunter, chief engineer of the Manchester Ship Canal, to the Senate Committee on Interoceanic Canals giving a statement of his views in regard to the dangers of the lock-canal plan. Also editorial. 6800 w. Eng Rec—June 2, 1906. No. 77072.

Mining Methods for the Culebra Cut. H. M. Chance. A discussion of the applicability of the well-known "milling" system of undercutting by tunnels and shafts, to the economical excavation of the Culebra Cut on the Panama canal. 3000 w. Engineering Magazine—July, 1906. No. 77688 B.

What is Worth While? Editorial discussing the question of a sea-level or lock-canal at Panama, favoring the latter. 2500 w. Eng News—May 31, 1906. No. 77042.

Pier Sheds.

The New Steel Pier Sheds on the East River, New York. Illustrates and describes pier sheds being erected which will be leased for terms of ten years; the improvements and standard design, and the methods of construction are considered. 2000 w. Eng Rec—June 9, 1906. No. 77240.

Port.

New Lake Port. An illustrated account of a new harbor, known as Gary, being developed by the United States Steel Corporation at the extreme southern end of Lake Michigan in Indiana. 2500 w. Marine Rev—June 21, 1906. No. 77448.

River Flow.

See Mechanical Engineering, Hydraulics.

Ship Canals.

The Bruges Ship Canal (Der Brügger Seekanal). W. Kaemmerer. A detailed account of the canal from Bruges to the North Sea at Heyst, now nearly completed. It is 12.75 kilometres in length, with 8 metres depth of water. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1906. No. 77602 D.

The Great Ship Canals of the World. Ambrose G. Grandpre. Brief accounts of ten such canals already built. 2500 w. Technograph—No. 20. No. 77167 D.

Tides.

Pacific Coast Tides and the Determination of Mean Sea Level. W. B. Dawson. Extract from a report entitled "Tide Levels and Datum Planes on the Pacific Coast of Canada," presented before the Canadian Soc. of Civ. Engrs. 1000 w. Eng News—June 28, 1906. No. 77531.

Wharves.

Steel Wharves at Manila. Sections and description of two wharves under construction. Both have platforms of steel beams and girders carrying reinforced concrete floor slabs and supported by rows of small reinforced concrete piers with steel shells and pile foundations. 1000 w. Eng Rec—June 16, 1906. No. 77340.

MISCELLANY.

Reclamation.

Engineering Construction by the United States Reclamation Service. M. O. Leighton. Information concerning the great water-supply installations west of the Mississippi for the purposes of irrigation, which involve an expenditure of over $30,000,000. Ills. Discussion. 5500 w. Jour N Eng W-Wks Assn—June, 1906. No. 77502 F.

Reclaiming the Site of Grant Park, Chicago. An illustrated account of land being reclaimed for a city park in the business district along Lake Michigan. It will require 7,000,000 cu. yds. of filling. About 5,000,000 cu. yds. are already in place. 3700 w. Eng Rec—June 16, 1906. No. 77344.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Modification of the Cable Zero Conductor Resistance Test for Submarine Cables. G. B. Winkfield. Brief description of the proposed method, stating its advantages. 800 w. Elect'n, Lond—May 25, 1906. No. 77129 A.

Exchange.

A New Telephone Trunk Exchange in Birmingham. Describes some of the improvements introduced in this new exchange. One of the most interesting is the use of the telegraph sounder as an aid to the telephone circuits. Ills. 2000 w. Elect'n Lond—June 15, 1906. No. 77479 A.

Space Telegraphy.

On Directed Wireless Telegraphy. Prof. Dr. F. Braun. An account of recent experimental work in this field, which gives promise of a distinct advance. Also editorial. 4200 w. Elect'n, Lond—May 25, 1906. Serial. 1st part. No. 77130 A.

The Commercial Aspect of Wireless Telegraphy. Edwin Edser. A sketch showing the applications made and the successful working of over-sea transmission. 2200 w. Elec Engr, Lond—June 1, 1906. No. 77264 A.

Telegraph Works.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown. Gives the history and general description of the plant, and detailed descriptions of the submarine cable, instruments, batteries, and other products manufactured. Ills. 5500 w. Elec Engr, Lond—May 25, 1906. No. 77125 A.

DISTRIBUTION.

Sub-Station.

Toronto Terminal Station of the Toronto & Niagara Power Company. Illustrates and describes what is said to be the largest sub-station in point of capacity in the world and is to receive 30,000 K. W. at about 60,000 volts from Niagara Falls. 2000 w. Can Elec News—June, 1906. No. 77335.

Supply.

The General Supply of Electricity for Power and Other Purposes: Its Commercial Character and Controlling Management. James N. Shoolbred. Discusses the cause of the backwardness of England in electrical development, offering suggestions for a remedy. Discussion. 6500 w. Jour Soc of Arts—May 25, 1906. No. 77123 A.

Three-Wire.

Resistance Measurements in Three-Wire Systems with Unearthed Middle Wire (Die Bestimmung der Einzelurderstande in Dreileiternetze mit ungeerdetem Mittelleiter). Dr. E. Müllendorff. A discussion of the method of determining the resistance in multiple wire systems by comparing the voltages of the several wires. 1200 w. Elektrotech Zeitschr—May 24, 1906. No. 77648 B.

Transformers.

Transformers with Cooling Ribs (Transformator mit Kühlrippen). F. Niethammer. By the use of thin extended metallic ribs the radiating surfaces are increased, giving opportunity for air-cooling. 1200 w. Elektrotech u Maschinenbau—May 20, 1906. No. 77654 D.

Wiring.

Consumers' Installations. A. E. Woodhouse. Read before the Elec. Assn. of Victoria. Discusses the efficiency and protection from fire and shock in the wiring of buildings. 2200 w. Aust Min Stand—May 16, 1906. Serial. 1st part. No. 77468 B.

ELECTRO-CHEMISTRY.

Batteries.

Arrangement of Battery Cells. George M. Hopkins, in "Experimental Science." An explanation of the method of connecting batteries to secure the greatest efficiency. Diagrams. 1000 w. Sci Am Sup—June 16, 1906. No. 77290.

Bleaching.

Flour Bleaching with the Aid of Electricity. Brief illustrated description of apparatus used in this novel application of electricity. 800 w. Elect'n, Lond—June 8, 1906. No. 77378 A.

Electric Smelting.

Electric Furnace Methods of Iron and Steel Production. John B. C. Kershaw. Introductory review of what has been accomplished in this field, to be followed by articles dealing with the furnaces and processes now used in the electric production of iron and steel. Ills. 1300 w. Ir Trd Rev—June 28, 1906. Serial. 1st part. No. 77516.

Electrical Steel Melting at Disston Plant. Illustrations of the induction type of electric furnace used at this plant, near Philadelphia, which manufactures saws and tools. 1000 w. Ir Age—June 7, 1906. No. 77150.

Some Laboratory Experiments with Electric Furnace. J. W. Evans. An il-

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lustrated description of experiments, and of furnaces used. 1200 w. Can Min Rev—June, 1906. No. 77362 B.

Electrode.

A Simple Form of Rotating Electrode for Electrochemical Analysis. F. Mollwo Perkin. Read before the Faraday Soc. Describes a cathode, readily constructed in the laboratory, and gives some results obtained with it. 900 w. Elect'n, Lond—June 15, 1906. No. 77481 A.

Electrotypes.

Rapid Methods for Producing Electrotypes. Sherard Cowper-Coles. An illustrated description of methods for this work used in Europe and America. 1600 w. Elec Rev, Lond—June 15, 1906. Serial. 1st part. No. 77476 A.

Galvanizing.

Cold Galvanizing. Illustrated description of the electrolytic process and apparatus employed by the U. S. Electro-Galvanizing Company. 2500 w. Ir Age—June 21, 1906. No. 77406.

Niagara.

The Niagara Falls Electro-Chemical and Metallurgical Industry. Frank C. Perkins. The first of a series of articles describing the power-plants and distribution. 1000 w. Min Wld—June 2, 1906. Serial. 1st part. No. 77090.

Nitrogen.

Producing Fertilizer from the Atmosphere. William Herbert Hobbs. Describes an industry established about 50 miles north of Rome, Italy, for "fixing" the atmospheric nitrogen in a form suitable for plant food. 1200 w. Min Wld—June 2, 1906. No. 77091.

Zinc.

Electro-Metallurgy of Zinc. Erminio Ferraris. Read before the 6th Int. Cong. of Ap. Chem. Reviews what has been accomplished in the development of the thermo-electric zinc industry. 1200 w. Min Jour—June 16, 1906. No. 77471 A.

ELECTRO-PHYSICS.

Induction.

Induction Between Two Parallel Wires. George D. Shepardson. Explains methods of calculating the induction between parallel wires. 2300 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77510 N.

Iron Losses.

Devices for Determining the Energy Losses in Iron Sheets. Dr. Alfred Gradenwitz. Illustrates and describes testing apparatus of various types for making a magnetic examination of iron. 1000 w. Sci Am Sup—June 23, 1906. No. 77423.

Iron Losses in Alternating Current Commutator Motors (Die Eisenverluste von Wechselstrom-Kommutatormotoren). Dr. Niethammer. A study of hysteresis and eddy-current losses in alternating motors, with formulas and diagrams for practical use. 2000 w. Elektrotechnik und Maschinenbau—June 10, 1906. No. 77657 D.

Magnets.

Alternating-Current Magnets. D. L. Linquist. Gives a brief review of direct-current magnets in order to afford a comparison, and a description of the general features of magnets for alternating current, discussing the general principles of the theory. 2000 w. Elec Wld—June 23, 1906. Serial. 1st part. No. 77465.

Radio-Activity.

The Radio-Activity of Thorium Minerals and Salts. Bertram B. Boltwood. Describes experiments undertaken with the object of determining what proportion of the total *a*-ray activity of radio-active minerals was produced by the thorium present, and whether the activity due to thorium was in all cases proportional to the actual amount of this element contained in the mineral. 4500 w. Am Jour of Sci—June, 1906. No. 77157D.

The Radio-Activity of Thorium. H. M. Dadourian. Read before the Am. Phys. Soc. Describes experiments undertaken to determine the quantitative relation between the thorium activity of various minerals and separated salts, and their content of thorium. 2200 w. Am Jour of Sci—June, 1906. No. 77158 D.

The Radio-Activity of the Salts of Radium. Bertram B. Boltwood. A report of experimental investigations with general results and conclusions. 1800 w. Am Jour of Sci—June, 1906. No. 77156 D.

The Relation Between the Radio-Activity and the Composition of Thorium Compounds. H. N. McCoy and W. H. Ross. A study of compounds and minerals containing thorium; with or without uranium. 3000 w. Am Jour of Sci—June, 1906. No. 77159 D.

GENERATING STATIONS.

Alternators.

Inductor Alternators. E. S. Hawkins. Considers the advantages of the inductor construction, and explains the operating principle. Ills. 1200 w. Engr, U S A—June 1, 1906. No. 77082 C.

Armatures.

Series Parallel Armature Windings with Equipotential Connections. Prof. E. Arnold. The present number considers the design of series parallel windings, the action of equipotential connections, and the particular conditions for equipotential connections with slotted armatures. 3000 w. Elect'n, Lond—June 15, 1906. Serial. 1st part. No. 77478 A.

Brighton.

The Brighton Corporation's New Electricity Works. Detailed illustrated description. 1600 w. Elect'n, Lond—June 15, 1906. Serial. 1st part. No. 77480 A.

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Central Stations.

Hot Water, Heat, and Electric Light from a Central Station. Illustrated detailed description of the station at Marion, Ind., and the system of operation. 5000 w. Engr, U S A—June 1, 1906. No. 77080 C.

The Central Power Plant of the Oliver Estate, Pittsburg, Pa. A central plant, in the business part of a city, to furnish light, heat, and power to several large office buildings, and churches, a department store, club, and several smaller consumers. Ills. 1400 w. Eng Rec—June 23, 1906. No. 77432.

Commutation.

Mechanical Aids to Commutation. J. N. Dodd. Aims to define commutation and to explain the purpose and limits of the various devices meant to improve it. 6500 w. Elec Jour—June, 1906. No. 77313.

Construction.

Construction of a Power Plant Under Difficulties. Edward C. Kinney. An account of a plant at Gothenburg, Nebr., and the method of overcoming difficulties with water in digging the pit. 2000 w. Jour Assn of Engng Soc's—March, 1906. No. 77318 C.

Dynamos.

Repairing Dynamo Electric Machinery. Norman G. Meade. Illustrates and describes useful devices and methods. 1200 w. Power—July, 1906. No. 77522 C.

Hydro-Electric.

Hydro-Electric Plant at Albany, Ga. R. W. Hutchinson, Jr. Illustrates and describes a water power development in the south, at the Big Shoals on the Muckafoonee River. 2000 w. Elec Wld—June 16, 1906. No. 77347.

The American Falls Power, Light and Water Company, Limited, the Idaho Consolidated Power Company, and the American Falls Power Company. An illustrated description of the development of these power installations in Idaho. 2500 w. Elec Rev, N. Y.—June 2, 1906. No. 77110.

Madison River Power Company's Plant. G. W. Craven. Describes this river valley in Montana, and describes the plant for utilizing the power. 1700 w. Jour Assn of Engng Soc's—March, 1906. No. 77317 C.

The Hydro-Electric Station on the Sill near Innsbruck (Die Sillwerke bei Innsbruck). J. Riehl and C. Arldt. A very fully illustrated description of the hydraulic and electric features of the plant for supplying the city of Innsbruck with light and power. An average of 13,000 h. p. is developed and transmitted over a distance of 8 kilometres. Three articles. 7500 w. Zeitschr d Ver Deutscher Ing—May 19, 26, June 9, 1906. No. 77600 each D.

The Works of the Mexican Light & Power Co., Ltd. An account of the development of the power of the Necaxa waterfall, 95 miles from the city of Mexico. Ills. 4000 w. Eng Rec—June 9, 1906. No. 77234.

Winnipeg, Manitoba, 60,000-Volt Hydro-Electric Plant. V. D. Moody. Illustrated detailed description of a modern water power plant, which utilizes the water of the Winnipeg River. 3500 w. Elec Wld—June 23, 1906. No. 77464.

Iron Losses.

See Electrical Engineering, Electro Physics.

London.

The Greenwich Electricity Supply Station. Illustrated description of the London County Council's power-station. 3300 w. Engr, Lond—June 1, 1906. No. 77271 A.

Municipal Plant.

Oil-Engine Driven Electric Lighting Plant at Camden, N. J. H. B. Sweet. Illustrated description of a plant of interest on account of the motive power employed. 1200 w. Elec Wld—June 2, 1906. No. 77246.

LIGHTING.

Arc-Lamps.

Improvement in Arc-Lamps. Editorial discussion of several recent improvements introduced in arc-lamps. 2000 w. Engng—May 25, 1906. No. 77144 A.

Assembly Rooms.

Lighting of Public Halls and Lodge Rooms. J. R. Cravath and V. R. Lansingh. Illustrates different arrangements, giving a critical discussion of the methods used. 800 w. Elec Wld—June 2, 1906. No. 77248.

Bridge Lighting.

Electric Lighting of the Passy Bridge at Paris (Eclairage Electrique du Pont de Passy à Paris). E. Bret. Discussing especially the automatic apparatus for lighting and extinguishing the incandescent lamps by which the bridge is lighted. 1200 w. Génie Civil—May 5, 1906. No. 77611 D.

California.

The Edison System of Southern California. R. H. Ballard. Read before the Nat. Elec. Lgt. Assn. An account of this extensive system and its remarkable development. 2800 w. Elec Rev, N Y—June 23, 1906. No. 77443.

Consumption.

The Watt Consumption and Lighting Power of Edison Incandescent Lamps (Ueber Wattverbrauch und Lichtstarke der Edison Glühlampe). R. Lucas. A proof of the law that the illuminating power is proportional to the cube of the consumption of energy. 1000 w. Elektrotech Zeitschr—May 31, 1906. No. 77651 B.

We supply copies of these articles. See page 799.

Illumination.

Improvements in the Technology of Illumination (Neues aus der Beleuchtungstechnik). Arthur Libesny. A general discussion before the Vienna Electrotechnical Society, referring to metallic-filament incandescent lamps, also improvements in arc and mercury-vapor lamps. Two articles, 5000 w. Electrotech u Maschinenbau—May 20, 27, 1906. No. 77655 each D.

Some Physiological Factors in Illumination and Photometry. Louis Bell. Abstract of a paper read before the Ill. Engng. Soc. Points out some of the bearings of physiological optics upon practical illumination, its measurement and the limitations of its efficiency. 3000 w. Elec Rev, N Y—June 16, 1906. No. 77308.

Some Points in Illumination. Cole Tay. Discusses the fundamental characteristics of the problem and how to adapt them to the conditions in question. 2300 w. Elec Wld—June 2, 1906. No. 77247.

Lamp Testing.

See Electrical Engineering, Measurement.

Resorts.

Electric Lighting at Summer Resorts on the Atlantic Coast. An illustrated article describing illuminating effects at Coney Island, Atlantic City, Long Branch, and Asbury Park. 7400 w. Elec Wld—June 2, 1906. No. 77245.

Street Lighting.

High Efficiency Incandescent Lamps for Street Lighting. Francis W. Wilcox, Read before the Ill. Engng. Soc., N. Y. Concerning recent improvements in the new high efficiency series lamps, and their advantages for street lighting. 3500 w. Elec Rev, N Y—June 2, 1906. No. 77112.

Street Lighting. C. Turnbull. Briefly considers Nernst lamps and lanterns, suggesting improvements in design. 800 w. Elec Rev, Lond—June 8, 1906. No. 77380 A.

Suggestions for Standard Methods of Arranging and Comparing Street Lighting Methods (Vorschläge zur Einheitlichen Beurteilung und Verfahren zur Berechnung der Strassenbeleuchtung). L. Bloch. A discussion of the best method of arranging street lamps, suggesting a standardizing of practice. 4000 w. Elektrotech Zeitschr—May 24, 1906. No. 77646 B.

Tantalum Lamp.

The Spherical Reduction Factor of Tantalum Lamps. Dr. Clayton H. Sharp. A series of tests showing that the spherical reduction factor of tantalum lamps varies considerably is discussed, and data relating to the variations are given. Ills. 1600 w. Elec Wld—June 16, 1906. No. 77348.

MEASUREMENT.

Lamp Testing.

The Testing of Incandescent Electric Lamps. Preston S. Millar. Remarks on the fallacies of lamp tests, and precautions to be taken to make the tests of value. 2500 w. Elec Wld—June 16, 1906. No. 77349.

Meters.

A New Induction Watt-Hour Meter. G. Faccioli. Illustrated description and study of the meter recently invented by William Stanley. 2300 w. Elec Wld—June 16, 1906. No. 77350.

Electric Meter Testing. Ernest B. True. Suggestions for the proper testing of meters and discussion of methods. Ills. and tables. 5800 w. Technograph—No. 20. No. 77166 D.

Tests and Certificates of the Electric Testing Bureau (Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfamter). A report of the Reichsanstalt illustrating a single-phase induction meter accepted for official calibration. 3000 w. Elektrotech Zeitschr—May 24, 1906. No. 77647 B.

Oscillograph.

An Oscillograph. M. K. Akers. Historical review of the development of this instrument for recording variations of electromotive force or current. Ills. 2000 w. Technograph—No. 20. No. 77168 D.

Resistance.

The Testing of a Low Resistance by Means of Ordinary Laboratory Instruments. G. W. Burley. Describes an attempt made by the author to determine the value of low resistances, when the use of standardized instruments is prohibited. 1800 w. Elec Engr, Lond—June 15, 1906. Serial. 1st part. No. 77473 A.

Standards.

The Board of Trade Electrical Standards Laboratory. Deals with the electrical quantities that can be referred to resistance, current, and electromotive force. Illustrates and describes the laboratory and its work. 5500 w. Engng—May 25, 1906. No. 77139 A.

Testing.

Factory Testing of Electrical Machinery. F. Parkman Coffin. Illustrates and describes the work as carried out by the General Electric Company. 3000 w. Harvard Jour of Engng—June, 1906. Serial. 1st part. No. 77331 D.

Testing for Central Stations. Clayton H. Sharp. Illustrated description of the Electrical Testing Laboratories of New York and their facilities. 3000 w. Cent Sta—June, 1906. No. 77066.

Voltage.

A Simple Method of Measuring Sparking Voltages. E. A. Watson. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Gives a method believed

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to be new, and its chief feature is the entire elimination of any measuring instruments subjected to the working potential, and the consequent simplification of the high-tension circuit. 1500 w. Elec Engr, Lond—June 15, 1906. Serial. 1st part. No. 77474 A.

MOTORS.

Alternating.

The Alternating Series Motor of the Siemens - Schuckert Works (Wechselstrom-Reihenschlussmotoren der Siemens-Schuckertwerke). Rudolf Richter. A complete description of an improved series alternating motor, comparing it with the repulsion motor. Two articles. 10000 w. Elektrotech Zeitschr—June 7, 14, 1906. No. 77652 each B.

Bearings.

The Inspection of Motors and Motor Bearings. William Kavanagh. Suggestions for determining the clearance between armature and pole pieces, the wear of bearings, etc. 1000 w. Elec Wld—June 2, 1906. No. 77249.

Classification.

The Classification of Alternate-Current Motors. V. A. Fynn. Proposes a classification for these alternate-current commutator machines, which the author believes to have a rational basis. 4800 w. Diagrams. Elect'n, Lond—May 25, 1906. Serial. 1st part. No. 77128 A.

Continuous Current.

Continuous Current Motors. J. W. Burleigh. Gives a short description of a two-pole magnet system and some comparative designs. Diagrams. 1500 w. Elec Rev, Lond—June 8, 1906. No. 77383 A.

Hunting.

Hunting Action of Direct-Current Interpole Motors (Pendelerscheinungen an Gleichstrommaschinen mit Hilfspolen). W. Siebert. Discussing the conditions under which auxiliary poles may produce oscillations. 1200 w. Elektrotech Zeitschr—May 31, 1906. No. 77650 B.

Induction Motors.

The Exciting Current of Induction Motors. A. S. McAllister. Brief outline discussion calling attention to the fact that the value of the wattless component may be ascertained directly from the volume of the air-gap, and the volume of the core material, without reference to the required magnetomotive force, the number or the distribution of the primary coils. 800 w. Elect'n, Lond—June 8, 1906. No. 77379 A.

Interpole.

The Application of the Auxiliary-Pole Type of Motor. J. M. Hipple. An explanation of how a motor of this type makes a saving in the lay-out and operation of the industrial power plant and its distributing system. Diagrams. 1200 w. Elec Jour—June, 1906. No. 77315.

Iron Losses.

See Electrical Engineering, Electro Physics.

Repulsion.

A Modified Repulsion Motor. Gives a modified method of connecting up a repulsion motor, as suggested by F. Punga, in the *Elektrotechnische Zeitschrift*. 1500 w. Elec Rev, Lond—June 8, 1906. No. 77384 A.

Shunt Motors.

A Graphic Method of Determining the Ratio of Speed-Voltage Variation in Shunt Motors. A. E. Kennelly. Shows how the speed-voltage may be determined graphically when the usual data concerning the magnetic and electric circuits are available. 2000 w. Elec Wld—June 23, 1906. No. 77466.

MISCELLANY.

Electricity.

Electricity in the Home. Harold Stannard. An illustrated article describing many applications of electricity to domestic service. 1600 w. Sci Am Sup—June 2, 1906. No. 77048.

Extension.

Extending the Uses of Electricity. H. S. Knowlton. An illustrated article considering its applications to domestic service. 800 w. Cassier's Mag—June, 1906. No. 77294 B.

INDUSTRIAL ECONOMY

Canals.

The Coal Traffic on French Canals. An account of the conditions under which coal cargoes are carried on the canals of France. 4500 w. Ir & Coal Trds Rev—June 8, 1906. No. 77393 A.

Cost Keeping.

Cost Keeping on Public Works. Waldo S. Coulter. Suggestions with remarks on what the reports should show. 1000 w. Eng News—June 14, 1906. No. 77438.

Education.

The Education and Training of Engineers—Civil and Naval. W. H. White. Discusses the report by the Committee of British engineering societies appointed to consider the best method of

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training all classes of engineers. 9500 w. Nineteenth Century—June, 1906. No. 77298 D.

Exposition.

The Milan International Exposition (Die Internationale Ausstellung in Mailand). With plan of the grounds, and a general account of the arrangement of the Exposition. 1500 w. Stahl u Eisen—June 1, 1906. No. 77632 D.

Japan.

The Economic Future of Japan. Achille Viallate. Discusses the efforts being made to transform the economic system of the country, and the outlook as affecting other nations. 5000 w. Jour Fr Inst—June, 1906. No. 77323 D.

Labor.

The Insurance of Labor in France. Editorial on the action taken to make employers responsible for labor in case of accident or sickness, the State being responsible, should the owner fail. 3000 w. Engng—May 25, 1906. No. 77142 A.

Municipal Ownership.

The Agitation for Municipal Ownership in the United States—Its Origin, Meaning, and Proper Treatment. Everett W. Burdett. Abstract of an address before the Nat. Elec. Lgt. Assn. Shows that public ownership has not produced the results desired, and suggests public control as better. 3500 w. Elec Rev, N. Y.—June 23, 1906. No. 77444.

Patents.

Patent Methods and Industry (Patentwesen und Industrie). Franz Zeis. Showing the relations of an efficient patent law to the development of technical industries with a comparison of the German and Austrian systems. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 8, 1906. No. 77618 D.

Population.

Urban Tendencies of Population as Affecting the Problems of Engineers. Erastus G. Smith. Gives statements showing the tendency toward life in cities, and discusses the causes and effects of concentration of population upon engineering problems. General discussion. 10500 w. Jour W Soc of Engrs—June, 1906. No. 77505 D.

Railways.

The Railways of the World (Die Eisenbahnen der Erde). Condensed statistics of the development of the railways of the earth from 1900 to 1904, with map. 2000 w. Stahl u Eisen—June 1, 1906. No. 77633 D.

Systematizing.

The Need for Systematic Methods in the Conduct of Engineering Works. W. O. Horsnaill. Shows the need of systematic methods. 1000 w. Elec Rev, Lond—June 8, 1906. No. 77382 A.

Typical Factory Systems and Their Practical Results. Egbert P. Watson. A comparison of the older establishments, purely commercial or mechanical in administration, with those including modern welfare methods. 3500 w. Engineering Magazine—July, 1906. No. 77685 B.

MARINE AND NAVAL ENGINEERING

Battleships.

French Dreadnoughts. A discussion of the proposed French battleship-cruiser, giving plans. 1700 w. Engr, Lond—June 1, 1906. No. 77270 A.

New Battleship Designs. Gives inboard profile, deck plans, and description of a powerful Russian design, and also an American design submitted to the Navy Department, comparing the two, and giving data for the guns of various ships. 1200 w. Int Marine Engng—July, 1906. No. 77452 C.

The New Battleship New Jersey, Illustrated description, with report of trial. 800 w. Int Marine Engng—July, 1906. No. 77451 C.

Cargo Steamer.

Lake Cargo Steamer Hoover & Mason, Built With Hopper Type of Hold. Longitudiual and transverse sections with description of a departure in ore-carrier construction, explaining the improvements. 1200 w. Naut Gaz—June 7, 1906. No. 77189.

Engine-Room.

Engine-Room Artificers. Editorial on the position of engine-room artificers in the Royal Navy. 2700 w. Engng—May 25, 1906. No. 77143 A.

Experimental Task.

Experimental Tank at Ann Arbor. Herbert C. Sadler. Illustrates and describes the tank and the method of preparation and testing of ship models. 2500 w. Marine Rev—June 7, 1906. No. 77207.

Fire Boat.

Milwaukee's New Fire Boat. Profile and description of a new steel fire boat of the two-pumps class, equipped with a water tower. 800 w. Marine Rev—June 14, 1906. No. 77306.

Launching.

The Launch of the "Lusitania." Illustrations and interesting account of the

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launch of the largest and heaviest ship yet floated. 2400 w. Engng—June 8, 1906. No. 77386 A.

Liner.

The Latest and Largest Steamship. Illustrates interesting features of the "Kaiserin Auguste Victoria," of the Hamburg-American line. 1000 w. Sci Am—June 16, 1906. No. 77285.

Mercantile Marine.

Ships and Ports. W. H. Wheeler. Two articles showing what the requirements of the commercial mercantile marine of the future are likely to be, and giving a classification of the ports of Great Britain according to the requirements of trade, aiming to furnish a guide as to the capacity of harbor works, etc. 3500 w. 1st article. Engr, Lond—June 8, 1906. No. 77390 A.

Oil-Tight Work.

Oil-Tight Work in Ships of Light Construction. Herbert Rowell. Read before the Inst. of Nav. Archts. Describes experiments made to ascertain the spacing of rivets necessary to ensure oil-tight seams and connections in ship structures where circumstances rendered the use of thin plates and bars necessary. Records were also taken to show the capability of light structures of this nature to support relatively heavy pressures. Ills. 1600 w. Engng—June 15, 1906. No. 77489 A.

Refrigeration.

See Mechanical Engineering, Heating and Cooling.

Salvage.

A Big Salvage Feat at Liverpool. Illustrates and describes an interesting work in salvage of a steamer beached in sinking condition in the Mersey. 600 w. Marine Rev—June 7, 1906. No. 77206.

Snag Boats.

The Snag Boats of the South. Day Allen Willey. Illustrated description of a boat employed in the St. Louis district for removing these obstacles to navigation. 1400 w. Sci Am—June 9, 1906. No. 77254.

Submarines.

Submarine versus Submersible Boats. Simon Lake. Explains the important differences in these types of underwater boats, and the reasons for some of the accidents that have occurred. Gives diagrams of types and results secured by submersible boats. 4500 w. Engr, Lond—June 29, 1906. No. 77897 A.

The Stability of Submarines. Sir William H. White. Read before the Royal Society. A record of the results of calculations made to determine the conditions of stability of submarine vessels in varying circumstances which may occur in service. 3000 w. Engng—May 25, 1906. No. 77145 A.

The Two Modern Types of Submarines. E. L. Warren. An explanation of the methods in use to maintain neutral equilibrium as exemplified in the Holland and Lake types. 2000 w. Yale Sci M—June, 1906. No. 77372 C.

Torpedo Boats.

Armorclads and Waterclads. Gives detail plans and description of a 20-knot 140-ft. seagoing subsurface torpedo boat, and presents its advantages as compared with the submarines. 2800 w. Marine Rev—June 7, 1906. No. 77205.

Tow Boat.

Paddle Tow Boat Kaiser Wilhelm II (Radschleppdampfer Kaiser Wilhelm II). O. Heesch. Detailed description of a powerful paddle towing steamer for service on the Elbe with illustrations of hull and engines. 1200 w. 1 plate. Schiffbau—May 23, 1906. No. 77658 D.

Turbine Steamers.

The Cunard Liner "Lusitania." Editorial discussion of this recently launched British vessel, which marks a distinct advance in size, speed and method of propulsion. 3300 w. Engng—June 1, 1906. No. 77269 A.

The Cunard Liner Lusitania. With illustrations of the hull before launching and a view of the stern showing rudder and one of the propellers. Data concerning the powering and the general equipment of the vessel are also given, including electric lighting, telephones, etc. 1800 w. Sci Am Sup—June 30, 1906. No. 77710.

The Dover-Ostend Turbine Steamship "Princesse Elisabeth." Illustrations, description and report of trials. 1500 w. Bul Int Ry Cong—May, 1906. No. 77508 E.

Two New Turbine Steamers. Illustrates the "Kingfisher" and the "Duchess of Argyll," giving short description. 400 w. Engr, Lond—May 25, 1906. No. 77148 A.

The Present Status of the Turbine as Applied to Marine Work. Herbert C. Sadler. Discusses the requirements in marine propelling instruments and considers the suitability of the steam turbine to meet the conditions. 4500 w. Jour Assn of Engng Soc's—March, 1906. No. 77316 C.

Wrecking the George W. Elder. An interesting illustrated account of a very difficult but successful raising of this steamer which sank in the Columbia river, Oregon. 1500 w. Marine Rev—June 28, 1906. No. 77740.

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MECHANICAL ENGINEERING

AUTOMOBILES.

Adams-Hewitt.

The 10-H. P. Adams-Hewitt Light Car. Illustrated description of a powerful but low-priced car having many features of interest. 1000 w. Autocar—May 26, 1906. Serial. 1st part. No. 77124 A.

Automobile Shops.

Where an Air-Cooled Car is Built. Illustrated description of the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y. 1300 w. Automobile—June 21, 1906. No. 77450.

Bearings.

Ball Bearings—Good, Bad, and Indifferent. Henry Hess. Read before the Soc. of Auto. Engrs. in New York. Discusses the principle upon which the ball bearing is built, the friction, destructive wear, causes, and remedies. 3000 w. Automobile—May 31, 1906. No. 77061.

Cooling.

Air-Cooling Systems for Motors. An illustrated article describing methods of air-cooling used in America, and discussing the construction of types of air-cooled cylinders. 1500 w. Automobile—June 21, 1906. No. 77449.

Water-Cooling Systems for Motors. Explains reasons for the cooling process and gives brief illustrated descriptions of several systems. 1500 w. Automobile—June 14, 1906. No. 77275.

Coventry Humber.

The 10 12-H. P. Coventry Humber Car. Illustrated description of the general arrangement, engines, rear axle, and control. 1600 w. Autocar—June 9, 1906. No. 77375 A.

Daimler.

The New 45-H. P. Daimler Car. Illustrated description of the latest car of this company, which shows a number of departures from previous cars of this make. 2000 w. Autocar—June 2, 1906. No. 77258 A.

Fittings.

Equipment for a Touring Car. The present number deals with articles that experience has shown to be desirable in the full equipment of a car for daily use about town. 2500 w. Automobile—June 28, 1906. Serial. 1st part. No. 77535.

Gasoline Car.

The Gasoline Car for Interurban Service. Extracts from a paper by F. W. Hild, read before the Iowa St. & Int. Ry. Assn. A review of the railway motor car and its capabilities; confined to internal combustion engines using gasoline as fuel. 3800 w. Ry & Engng Rev—June 2, 1906. No. 77087.

The Gasolene Car for Interurban Service. Extracts from a paper by F. W. Hild, read before the Iowa St. & Inter. Ry. Assn. Refers to various types of independent motor cars tried, and considers especially these cars as compared with the electric system. Concludes that they will prove useful in a field quite distinct from the standard electric system. 4800 w. R R Gaz—June 1, 1906. No. 77055.

Ignition.

A New Low-Tension Magneto. Illustrated description of the new system of ignition of the Albion Co. 1200 w. Autocar—June 9, 1906. No. 77374 A.

Ignition Devices for Automobile Motors (Die Zündvorrichtungen der Automobilmotoren). E. Konig. Discussing especially electrical ignition appliances, methods of timing the spark, comparing the advantages of the battery and the magneto. Two articles, 5000 w. Elektrotech & Polytech Rundschau—April 20, 27, 1906. No. 77659 each D.

The Ignition Timer and Its Functions. An illustrated description of the timer and its function. 1500 w. Automobile—May 31, 1906. No. 77062.

Iris.

The Latest 25-30 H. P. Iris Cars. Praise for the Iris cars with illustrated description of alterations made in the design. 600 w. Auto Jour—June 16, 1906. No. 77470 A.

Materials.

Materials for Automobile Construction. Thomas J. Fay. From a paper read before the Soc. of Auto. Engrs. in N. Y. Information on requirements for materials needed for various parts of automobiles. 2800 w. Automobile—June 28, 1906. No. 77534.

Motor.

Four-Cylinder Motorcycle Engine (Viercylinder-Fahrradmotor). Bruno Müller. Detailed illustrations of 3 horsepower four-cylinder motor for motor cycles, built at the National Firearms Works at Herstal, Belgium. 2000 w. Elektrotech u Polytech Rundschau—May 30, 1906. No. 77661 D.

Omnibuses.

Public Service Motor Vehicles. W. Worby Beaumont. General descriptive remarks on the progress made in the development of the motor omnibus, illustrating and describing types. 3000 w. Tram & Ry Wld—June 7, 1906. Serial. 1st part. No. 77403 B.

Rochet-Schneider.

The Rochet-Schneider Cars. Illustrated description of these cars which are

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made in several sizes. 900 w. Auto Jour—June 9, 1906. No. 77376 A.

Steam.

The Steam Plant of the White Motor Car. R. C. Carpenter. Considers in detail this system, which is at present only applied to propulsion of motor cars, showing the economic results obtained by the use of steam of high pressure and high temperature. Ills. 3000 w. Sib Jour of Engng—June, 1906. No. 77324 C.

The Weyher and Richemond Steam Automobile (Automobile à Vapeur des Etablissements Weyher et Richemond). F. Drouin. Illustrated description of an 18 h. p. steam machine with flash boiler, engines, and chassis. 1500 w. Génie Civil—May 12, 1906. No. 77612 D.

COMBUSTION MOTORS.

Alcohol.

The Industrial Uses and Value of Alcohol. Henry Hale. Mentions ways in which grain alcohol will take the place of other fluid when the tax upon it is removed, and discusses its importance as a producer of light, heat and power. 1700 w. Sci Am—June 23, 1906. Serial. 1st part. No. 77417.

The Use of Alcohol as a Fuel for Gas Engines. H. Diederichs. Considers the fuel value and the physical properties of alcohol, and the details of the alcohol engine, whenever they differ from the gasoline or crude oil machine. The efficieny and cost are also briefly discussed. Ills. 5000 w. Int Marine Engng—July, 1906. No. 77454 C.

Engines.

Phenomena of the Working Fluid in Internal-Combustion Engines. Extracts from a paper by Dugald Clerk, at meeting of the Royal Society. An investigation of the specific heat of, heat-flow from, and other phenomena of the working fluid in the cylinder of the internal combustion engine. 2800 w. Jour Gaz Lgt—May 22, 1906. No. 77065 A.

Gas Engines.

Notes on Gas Engines (Ueber Gasmaschine). Alfred Menzel. A general review of gas power generation, including gas producers, engine details, regulation and operation. Three articles. 8000 w. Elektrotech u Maschinenbau—May 27, June 3, 10, 1906. No. 77656 each D.

Rational Methods of Gas-Engine Powering. Sanford A. Moss. Gives general principles for obtaining approximate results, and rational formulas for exact results if actual coefficients, etc., are known. Only four-stroke-cycle stationary engines are considered. 3000 w. Power—July, 1906. No. 77521 C.

Gaseous Mixtures.

The Explosion of Gaseous Mixtures, and the Specific Heat of the Products. B. Hopkinson. A report of experimental investigations, comparing the results with the work of other investigators. 3300 w. Engng—June 15, 1906. No. 77485 A.

Gasoline Motors.

Some Recent Interesting Industrial Applications of the Gasoline Motor. An illustrated article describing unusual applications. A motor-driven sewage-collecting wagon; a wagon for trolley inspection; air compressor motor, etc. 2700 w. Sci Am Sup—June 16, 1906. No. 77288.

The 30-35-H. P. Simms Petrol Engine. Brief illustrated description of an engine designed for heavy commercial vehicles, such as omnibuses. 400 w. Auto Jour—June 2, 1906. No. 77259 A.

Gas Power.

Gas Power. Oskar Nagel. Explains the causes of the progress of the gas engine industry. 2000 w. Elec Chem & Met Ind—June, 1906. No. 77250 C.

Igniters.

Experiments on Gas Engine Igniters. F. W. Springer. Illustrates and describes experiments used in an experimental study of ignition apparatus commonly used in gas engines. 3800 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77515 N.

Oil Engines.

The Effect of Water Injection on Crude-Oil Engines. Robert F. McKay. Discusses the advantages and disadvantages of water injection. 1000 w. Engng—May 25, 1906. No. 77140 A.

Producer Gas.

Producer Gas and Gas Producers. Samuel S. Wyer. Read before the Illinois Clay-Workers' Assn. Considers the constituents of producer gas and gives illustrated descriptions of types of gas producers. 1600 w. Brick—June 1, 1906. No. 77161.

Producer Gas Power. Julius Wile. Considers reasons for the popularity of producer gas, its efficiency, etc. Ills. 1000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77513 N.

Starting.

On Some Methods for Starting Explosion Engines. E. Butler. Briefly describes eight methods used and describes experiments made by the writer, giving diagrams. 4000 w. Mech Engr—June 2, 1906. Serial. 1st part. No. 77262 A.

Suction Gas.

Suction Gas Producers. Oskar Nagel. An explanation of this system of gas-producer plants. 1200 w. Eng & Min Jour—June 9, 1906. No. 77196.

Suction Gas Producer Trials. The first of a series of articles giving an account of the trials of suction gas plants at the Royal Agricultural Society's Show.

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Ills. 1600 w. Engr, Lond—June 15, 1906. Serial. 1st part. No. 77482 A.

HEATING AND COOLING.

Atmospheric Regulation.

Artificial Regulation of Atmospheric Humidity and Temperature. Illustrated description of a machine designed to regulate artificially the ratio between the temperature and the humidity by passing water over a large cooling surface, over which, at the same time, large volumes of air are being drawn. 2000 w. Sci Am—June 23, 1906. No. 77418.

Central Plant.

A Central Steam Heating and Power Plant. W. N. Zurfluh. Illustrated description of the plant in Springfield, Ohio. 3000 w. Engr, U S A—June 15, 1906. No. 77368 C.

Hospital.

Heating and Ventilating a Hospital. Illustrated description of the combination of direct and indirect steam heating installed in St. Luke's Hospital, Utica, N. Y. 2000 w. Met Work—June 2, 1906. No. 77063.

Hot Water.

Computations for Hot Water Heating (Berechnung von Heisswasserheizungen). A. Goebel. With very complete tables and diagrams for determining the proportions of a hot-water system for a required heating capacity. 7500 w. Gesundheits-Ingenieur—June 2, 1906. No. 77638 B.

Construction and Application of the Brückner Heating System (Die Konstruktiven Grundlagen und die Praktische Augestaltung der Brücknerheizung). W. Brückner. Describing a hot-water heating system in which the circulation is accelerated by the action of steam in the main riser. 3500 w. Gesundheits-Ingenieur—June 2, 1906. No. 77636 B.

The Determination of the Emission of Heat from Hot-Water Apparatus (Zur Regelung der Warmeabgabe bei Warmwasserheizung). G. de Grahl. With curves and tables derived from the formula of Rietschel for computing the emission of heat from radiators for various temperature differences. 2000 w. Gesundheits Ingenieur—May 19, 1906. No. 77634 B.

The Theory of the Accelerated Circulation System of Hot-Water Heating (Zur Theorie des Schnellumlauf-Warmwasserheizung). Dr. Fritz Hasenöhrl. An examination of the action of steam in the main riser in accelerating the circulation in a hot-water heating system. 3000 w. Gesundheits-Ingenieur—June 2, 1906. No. 77637 B.

Post Office.

Heating and Ventilating Plant of the Indianapolis Post Office and Custom House. Plans and description of a plant for a 4-story building built upon three sides of a hollow square, and occupying an entire city block. Both direct and indirect radiation are used. 5200 w. Eng Rec—June 9, 1906. No. 77235.

Refrigeration.

Management of an Absorption System. W. S. Luckenbach. Suggestions for difficulties that may arise, and for the operation of the plant. 1500 w. Engr, U S A—June 15, 1906. No. 77369 C.

Cold Storage on Board Ship. Sydney F. Walker. The first of a series of articles discussing the problems in connection with cold storage on ships. Ills. 3500 w. Int Marine Engr—July, 1906. Serial. 1st part. No. 77453 C.

Speed of Ammonia Compressors. R. L. Shipman. Some observations in regard to results of high speed of ammonia compressors, a report of tests made, and conclusions. Ills. 4000 w. Ice & Refrig—June, 1906. No. 77100 C.

Schools.

Comparison of Heating and Ventilating Plants Installed in Chicago Public School Buildings at Various Periods. An analysis of the cost of installation, fuel consumption, maintenance and efficiency. 1200 w. Eng & Min Jour—June 16, 1906. No. 77346.

Heating and Ventilating a Modern School Building. C. Dix McArthur. Describes a school of medium size, No. 42, the Bronx, New York City, which presents a good example of a high pressure system; ventilating by steam engine driven blowers and heating with exhaust steam. Ills. 1800 w. Dom Engng—June 16, 1906. No. 77334.

Heating a School Building by a Warm Air Furnace. Plans and explanation, submitted by T. J. Grier for a design to meet the requirements of compulsory ventilation. Ills. 2000 w. Met Work—June 9, 1906. No. 77160.

Steam Heating.

The Flow of Steam through Regulating Valves in Low-Pressure Steam-Heating Plants (Ueber den Dampfdurchgang durch Regulierventile in Niederdruckdampfheizungen). H. Zyka. Applying the formula of Gutermuth to the regulation of low-pressure steam heating, with tables and diagrams. 7500 w. 3 plates. Gesundheits-Ingenieur—May 26, 1906. No. 77635 B.

Steam.

Modified Systems in Steam Heating. The present article illustrates and describes the Webster vacuum heating system. 1000 w. Met Work—June 2, 1906. Serial. 1st part. No. 77064.

Ventilation.

Notes on the Theory of Disc Ventilating Fans (Beitrag zur Theorie der Schrauben Ventilatoren). C. F. Holmboe. Discussing the best shape of blades, deliveries of air for various speeds, and

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general proportions of ventilating disc fans. 2500 w. Zeitschr d Ver Deutscher Ing—June 9, 1906. No. 77605 D.

Working Out a Ventilating System for a Telephone Exchange. Louis Rosenberg. Illustrated description of the plant designed for the operating room of the Cuyahoga Telephone Co. 2500 w. Heat & Vent Mag—June, 1906. No. 77501.

HYDRAULICS.

Flow.

Researches for the Determination of a Formula for the Flow of Water over Natural River Beds (Versuch der Aufstellung einer Geschwindigkeitsformel für Naturliche Flussbette). R. Siedek. A review of the previous paper of Dr. Max Matakiewicz, comparing his results and the author's with actual measurements. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—May 26, 1906. No. 77622 D.

The Friction of Flowing Water in Pipes (Strömung Reiben der Flussigkeiten in Rohrleitungen). L. J. Bodaszewski. A review of the formulas of Helmholtz, Neumann and others, with tables computed for the constants under various conditions. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—May 25, 1906. No. 77615 D.

Oil Pumping.

Rifled Pipe for Pumping Heavy Crude Fuel Oil. John H. Isaacs. Explains the troubles encountered in trying to pipe this oil, and the results obtained with rifled pipe. Describes the rifling machine used, giving illustrations. 2000 w. R R Gaz—June 8, 1906. No. 77233.

Pumps.

High-Lift Turbine Pumps. Their Design and Efficiency. R. J. Durley. A study of the principles which have been applied to extend both the efficiency and the capacity of the centrifugal pump, with examples of service applications. 4500 w. Engineering Magazine—July, 1906. No. 77683 B.

MACHINE WORKS AND FOUNDRIES.

Bells.

The Bell Industry. Storrs Ely Emmons. Brief illustrated account of the factories at East Hampton, Conn., and their history. 1000 w. Mach, N Y—June, 1906. No. 77098 C.

Boiler Making.

Laying Out a Plain Cylindrical Boiler. George Guntz. Directions, with diagrams. 1200 w. Boiler Maker—June, 1906. No. 77251.

Boring.

A Corliss Cylinder Boring Machine. Illustrated description of a machine designed for simultaneously machining the bore, valve chambers and flanges of Corliss cylinders up to 36 inches bore by 8 ft. long. 500 w. Am Mach—Vol. 29. No. 212 No. 77057.

Brazed Joints.

The Strength of Brazed Joints in Steel Wire. Henry Louis. Read before the British Inst. of Min. Engrs. Reports tests made to determine whether it is possible to produce a brazed joint equal in strength to the original wire. 1200 w. Ir & Coal Trds Rev—June 15, 1906. No. 77493 A.

Cast Iron.

Cast-Iron in the Foundry. Abstract of a paper by P. Longmuir, read before the W. of Scotland Ir. & St. Inst. Discusses the composition, treatment, etc., to produce the best castings. 2500 w. Mech Engr—June 2, 1906. No. 77263 A.

Malleable Cast Iron, Its Manufacture and Its Physical Properties. G. A. Akerlind. Read at meeting of the Scandinavian Tech. Soc. A discussion of the manufacture and properties of this material. 4000 w. R R Gaz—June 8, 1906. No. 77231.

Cores.

Core Sands and Core Binders. E. D. Frohman. Read before the Cleveland Foundry Foremen. Discusses the question of sands and of core compounds, giving a report of tests and showing that the amount of loam in the sand determines what core binder must be used. 2000 w. Foundry—June, 1906. No. 77320.

Multiple Core Molding. H. J. McCaslin. Describes this method of core making, which is especially adapted to small castings. Ills. 1500 w. Foundry—June, 1906. No. 77321.

Corrosion.

Oil Corrosion in Cylinders. Harry Spurrier. An account of the writer's experience and the remedy applied. 1200 w. Power—July, 1906. No. 77519 C.

Cranes.

The Electric Crane in the Foundry. Harry Sawyer. Read at Cleveland meeting of the Am. Found. Assn. Remarks on the requirements of these cranes, the conditions under which they are operated, high speeds, control, etc. 2000 w. Ir Trd Rev—June 14, 1906. No. 77274.

Dies.

Making a Blanking Die. C. F. Emerson. Names the essential things to be considered in making blanking dies, and the method of making them. Ills. 1200 w. Mach, N Y—June, 1906. No. 77099 C.

Drafting Rooms.

A Drafting Office System. A. Jacobs. Explains a system which it is believed may be used as a basis for a system to meet any requirements. 2000 w. Am Mach—Vol. 29. No. 26. No. 77527.

Draftsmen.

The Question of Men and Salaries in the Drafting Room. George F. Summers.

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A statement of existing conditions, considering the value of a draftsman, the pay, etc. 1400 w. Am Mach—Vol. 29. No. 22. No. 77059.

Electric Driving.

Electric Power Transmission. E. J. Erskine. Read before the Engng. Assn. of N. S. W. On the advantages to be gained by electric driving both in small shops and large establishments, some points to be considered in the installation, etc. 2700 w. Aust Min Stand—May 16, 1906. No. 77469 B.

The Electrical Equipment of the Olds Gas Power Company, Lansing, Michigan. Description of a factory where they utilize the power developed in the testing department. 2200 w. Am Mach—Vol. 29. No. 24. No. 77276.

Electric Works.

The Western Electric Company, North Woolwich. An illustrated description of this English branch of this large manufacturing industry. 2500 w. Elec Engr, Lond—May 25, 1906. No. 77126 A.

Furnaces.

The Scientific Control of the Operation of Industrial Furnaces (Le Controle Scientifique de la Marche des Fours Industriel). H. le Chatelier. An address before the students of the University of Liége, discussing the extent to which the measurement of temperatures, analyses of gases, and scientific observations, enables close control to be secured. 10000 w. Revue de Métallurgie—June, 1906. No. 77671 H.

Gear Cutters.

The Gleason Bevel Gear Generator. Illustrates and describes an ingenious machine for the cutting of bevel gears, and explains the object sought by the combination of movements. 2500 w. Ir Age—June 21, 1906. No. 77404.

Grinding.

Earlier and Modern Wet-Grinding Machines and Practice. H. F. Noyes. A discussion of the grinding machine, considered as a cutting tool, showing the progress in design, scope, and performance. 3000 w. Engineering Magazine—July, 1906. No. 77682 B.

Grinding Machines for Large Ball Races. Illustrated description of a machine for grinding large ball races and rings used on pedestal gun mounts. 1200 w. Am Mach—Vol. 29. No. 22. No. 77058.

Modern Grinding. Joseph Horner. Comments on the advances made in precision grinding, and illustrates and describes types of grinding machines. 2800 w. Cassier's Mag—June, 1906. No. 77295 B.

Lathes.

A Huge Lathe. Illustration, with description, of a lathe weighing 240 tons recently constructed for steam turbine work for marine propulsion. 1200 w. Engr, Lond—June 1, 1906. No. 77272 A.

A Relieving Attachment for the Lathe. H. J. White. Engravings and description of a successful device for relieving taps and cutters. 700 w. Am Mach—Vol. 29. No. 23. No. 77216.

High-Speed Turret Lathe. Illustrated description of a new machine built especially for rapidly machining cast-iron work, such as gears, pulleys, cones and similar parts up to 15 inches diameter. 1200 w. Am Mach—Vol. 29. No. 25. No. 77407.

Molding.

Mechanical Moulding Operations in the Foundry (Le Moulage Mécanique des Pièces de Fonderie). Léon Guillet. A systematic discussion of the design and operation of moulding machines, with illustrations of machines of American, German, and French design. Serial. Part I. 3000 w. Génie Civil—May 12, 1906. No. 77613 D.

Two Ways of Molding a Heavy Gap Press Body, at the Perkins Machine Company's Iron Foundry, Warren, Mass. R. H. Palmer. Illustrated description of the methods. 2400 w. Am Mach—Vol. 29. No. 23. No. 77215.

Nuts.

Making Nuts and Rings Without Waste. An illustrated article explaining the principles of the three different methods used. 1700 w. Ir Age—June 28, 1906. No. 77500.

Perforating.

A Perforating Press. Explains why perforated screens are preferred to wire screens and gives illustrations and description of machine for handling plates up to 60 inches. 1200 w. Am Mach—Vol. 29. No. 26. No. 77526.

Portable Tools.

Portable Electric Tools and Their Industrial Application. Abstract of a paper by Andrew Stewart, read before the Glasgow Tech. Col. Sci. Soc. Discusses considerations involved in the design of such tools, and some of the types and their advantages. 3000 w. Mech Engr—May 26, 1906. No. 77131 A.

Rolling Mill.

A German Cold Rolling Mill. Illustrated description of a mill made in Düsseldorf, Germany. 1200 w. Ir Age—June 14, 1906. No. 77252.

Sand.

Notes on Moulding Sands (Notes sur les Sables à Mouler). M. Vinsonneau. An exhaustive study of the constitution and properties of foundry moulding sands, with diagrams and tables for practical use in mixing. 7500 w. Revue de Métallurgie—April, 1906. No. 77665 H.

Screws.

Automatic Safety Attachment for

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Screw-Cutting. Illustrated description of an ingenious device which makes it mechanically imposible to close the clasp-nut except at the proper moment. 1000 w. Engng—June 8, 1906. No. 77388 A.

Shops.

The Construction of the Lidgerwood Plant at Waverly, N. J. Describes a new plant under construction for the manufacture of hoisting engines, cableways, etc., illustrating details. 2000 w. Eng Rec—June 9, 1906. No. 77237.

The Light Machine Shop. Edward H. McClintock. A discussion of its proportions and equipment. 3000 w. Mach, N Y—June, 1906. No. 77097 C.

The Passing of the Freeland Tool Works. An illustrated review of works founded in New York in 1845 and recently dismantled. 2200 w. Am Mach—Vol. 29. No. 23. No. 77214.

Steel Castings.

The Use of Steel Castings in Car and Truck Building. A. Stucki. Some of the desirable qualities of these castings are discussed. 800 w. R R Gaz—June 8, 1906. No. 77230.

MATERIALS OF CONSTRUCTION.

Alloys.

Recent Investigations upon Industrial Alloys (Recherches Récentes Faites sur les Alliages Industriel). Léon Guillet. A review of the modern theory of solid solutions, discussing the work of recent investigators, with especial reference to the practical applications of the newer alloys in manufacturing. 12000 w. Revue de Métallurgie—April, 1906. No. 77664 H.

Brasses.

A General Study of Special Brasses (Etude Générale des Laitons Speciaux). Léon Guillet. An exhaustive study of alloys of copper, zinc, and a third metal, the researches including brasses containing aluminum, manganese, iron, tin, lead, silicon, magnesium, antimony, or phosphorus. 20000 w. Revue de Métallurgie—May, 1906. No. 77667 H.

Effect of Arsenic on Brass. E. S. Sherry, in *The Brass World*. Showing that arsenic causes greater fluidity, and is not injurious unless more than 0.02 per cent. is present. 1000 w. Mech Engr—June 2, 1906. No. 77261 A.

Corrosion.

The Relative Corrosion of Wrought Iron and Steel. Henry M. Howe. A contribution to the discussion on the "Corrosion of Iron and Steel" at the meeting of the Am. Soc. for Test. Materials, June 22, 1906. 1400 w. Ir Age—June 28, 1906. No. 77499.

Overstrain.

Effect of Low Temperature on the Recovery of Steel from Overstrain. E. J. McCaustland. A report of tests made giving an outline of the scheme of experiments, with explanation of methods, conditions, and conclusions. 4500 w. Bul Am Inst of Min Engrs—May, 1906. No. 77176 C.

Shearing.

Shearing Strength of Structural Steels. Ch. Frémont, in *Revue de Métallurgie*. Reports experiments which lead to the conclusion that the shear diagram of an ordinary structural steel between two parallel cutting edges furnishes material for determining the elastic limit, the breaking strength, and ductility, with as much accuracy as the tensile test. 1800 w. Ir & Coal Trds Rev—June 8, 1906. No. 77392 A.

The Resistance of Structural Steel to Shearing (Résistance au Cisaillement des Aciers de Construction). Ch. Frémont. Discussing shearing as an action of tension and not of sliding, with diagram showing the relation of the shearing resistance to the elastic limit in tension. 4000 w. Revue de Métallurgie—May, 1906. No. 77668 H.

MEASUREMENT.

Bending.

A Simple Method for the Calculation of the Bending Strength of Curved Pieces. S. E. Slocum. Gives a method for calculating the strength of curved pieces having any form of cross section whatever. 1200 w. Eng News—May 31, No. 77040.

Cut-Meter.

The Warner Auto-Meter and Cut-Meter. Hugh Dolnar. Illustrates and describes the construction, operation, and calibration. 2500 w. Am Mach—Vol. 29. No. 25. No. 77409.

Centre of Gravity.

The Centre of Gravity of Spiraloid Systems (Centres de Gravité de Systèmes Spiraloides). Haton de la Goupillière. A study of the centre of gravity of masses arranged in a logarithmic spiral. 2000 w. Comptes Rendus—May 28, 1906. No. 77645 D.

The Determination of the Centre of Gravity of Discontinuous Systems (Centres de Gravité de Systèmes Discontinus). Haton de la Goupillière. A mathematical discussion, deriving general formulas for a number of bodies disposed in a circle. 2500 w. Comptes Rendus—May 14, 1906. No. 77642 D.

The Geometric Position of the Centre of Gravity (Lieux Géométriques de Centres de Gravité). Haton de la Goupillière. A mathematical examination of the position of the centre of gravity of a circular wire of increasing length. 2000 w. Comptes Rendus—May 21, 1906. No. 77643 D.

Crushing.

The Influence of Velocity upon the Law of the Deformation of Metals (In-

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fluence des Vitesses sur la Loi de Déformation des Metaux). P. Vieille & R. Lionville. Discussing the use of metal crushers for determining the pressures in guns, and showing the uncertainty of results made at such high velocities. 1000 w. Comptes Rendus—May 14, 1906. No. 77641 D

Elastic Limit.

Determination of the Elastic Limit of Metals (Mesure de la Limite Elastique des Métaux). R. Guillery. The elastic limit is determined by recording graphically the variations in the electrical resistance of the test piece while under tension. 3500 w. Revue de Métallurgie—June, 1906. No. 77670 H.

Micrometer.

A New Type of Micrometer. Walter C. Durfee. Describes what is called a rolling lens micrometer and its chief merit is said to be its ease of manipulation. 1000 w. Harvard Jour of Engng—June, 1906. No. 77333 D.

Pitometer.

The Pitometer and Its Uses. Edmund M. Blake. An illustrated description of this instrument and explanation of its uses in measuring the velocity of water in closed pipes. Discussion. 3000 w. Jour N Eng W Wks Assn—June, 1906. No. 77503 F.

Seismographs.

European Earthquake Recorders. Illustrates some of the instruments used and work of Prof. Milne, of the Shide Seismographic Observatory in the Isle of Wight, and in Italian observatories. 1800 w. Sci Am—June 16, 1906. No. 77286.

Speed Recorder.

Apparatus for Recording Rotative Speeds and Vibrations of Machines (Vorrichtung zum Aufzeichnen des Umlaufsgeschwindigkeit und des Ungleichförmigkeitsgrades von Maschinen). Friedrich Lux. Describing the application of a recording device to the Frahm speed and frequency indicator. 2000 w. Elektrotech Zeitschr—June 14, 1906. No. 77653 B.

Testing Machines.

Allowable Unit Loads on Knife Edges for Testing Machines and Heavy Weighing Scales. Jos W. Bramwell. Gives the writer's opinions which are based on extensive study of the weighing mechanism of testing machinery having knife edge supports for its levers. 700 w. Eng News—June 14, 1906. No. 77436.

Time Recorders.

The Calculagraph. An illustrated description of this machine and its mechanism, and of the method of using it in factory time keeping. 2000 w. Am Mach—Vol. 29. No. 22. No. 77056.

The "Dey" Time-Register. Illustrated description of a machine for registering the time of employés. 2000 w. Engng—June 15, 1906. No. 77486 A.

POWER AND TRANSMISSION.

Bearings.

The Lubrication of Bearings. A. M. Mattice. Practical matters in relation to the lubrication of bearings are discussed. 2000 w. Elec Jour—June, 1906. No. 77314.

Clutches.

Friction Clutches and Their Functions. An illustrated article, the present number explaining the construction of the ordinary cone clutch, the reversed cone clutch, cone clutch with split ring, and the expanding cylindrical ring clutch. 1300 w. Automobile—June 28, 1906. Serial. 1st part. No. 77536.

Compressed Air.

Air Compressors. Discusses the requirements, and gives illustrated descriptions of the important features in the designs of various makers. 15700 w. Engr, Lond (Sup)—June 15, 1906. No. 77484 A.

Compressed Air. Lucius I. Wightman. Brief review of the history, with discussions of its production, transmission and application. General discussion. 16500 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77299 D.

Conveyors.

The Belt Conveyor. Harold Sumner Farnham. From a lecture before the Mech. Engrs' class of 1906. Explains the fundamental principle of the belt conveyor, and illustrates and describes apparatus. 4500 w. Harvard Jour of Engng—June, 1906. No. 77332 D.

Elevators.

Electric Elevators. William Baxter, Jr. Describes elevator machines driven by electric motors, and illustrates several arrangements. 1800 w. Engr, U S A—June 1, 1906. No. 77081 C.

Some Notes on Braking Devices. Arthur W. Jones. On the reliability of the electro-magnetic brake, especially as applied to elevator gears. Ills. 1200 w. Elec Rev, Lond—June 15, 1906. No. 77475 A.

Friction.

Tests of "Compo" Cork Insert Friction Plates. John R. Nichols. Report of a test undertaken to determine the value of cork for increasing the frictional resistance of metallic surfaces in contact. 1000 w. Am Mach—Vol. 29. No. 23. No. 77217.

Gearing.

Diametrical and Circular Pitch. From the *English Mechanic and World of Science*. Explains these terms and the recent changes in their use and application, and gives the methods of calculating under each system. 2800 w. Sci Am Sup—June 9, 1906. No. 77255.

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Planetary Gears. Andrew Strom. Illustrates a number of arrangements of planetary gears, explaining their advantages, and the formulas for obtaining the speed ratios. 1800 w. Am Mach—Vol. 29. No. 26. No. 77528.

Worm-Gear Design. A. M. Sosa. Presents a formula for computing the pitch and lead of a worm. 1400 w. Am Mach—Vol. 29. No. 22. No. 77060.

Power.

Modern Tendencies in the Utilization of Power. John J. Flather. A review of power developments in the United States which have made possible great economy in production. 4000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77509 N.

Power Comparison.

Comparison between Steam and Electric Power in the Imperial Printing Office in Vienna (Vergleichende Angaben über Dampfbetrieb und Elektromotorischen Betrieb in der K. K. Hof und Staats druckerei in Wien). Leopold Nowotny. With diagrams of power curves and coal consumption, showing the advantages of electric driving. 1800 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—June 9, 1906. No. 77625 D.

Pneumatic Tubes.

An Improved Pneumatic Tube System. Illustrated description of a new system recently put in operation on some new lines installed for the Postal Telegraph Co., New York City. 2000 w. Eng Rec—June 2, 1906. No. 77074.

STEAM ENGINEERING.

Boiler Compounds.

The Intelligent Use of Boiler Compounds. R. L. Frank. Describes a method that has proved efficient and inexpensive, and costs about 25 cts. a horsepower. Ills. 3000 w. Engr, U S A—June 15, 1906. No. 77367 C.

Boilers.

Steam Boiler Inspections. Frank R. Fairweather. The various types of steam boilers in common use are considered, the causes of boiler explosions, and the importance of frequent inspections. Ills. 5000 w. Ins Engng—June, 1906. No. 77498 C.

The Hot-Air Boiler. Describes a pressure-generating device, known as a thermo-dynamic generator, explaining its action. 1200 w. Sci Am—June 16, 1906. No. 77284.

Condensers.

The Efficiency of Condensers and Its Effect on Power Station Costs. R. M. Neilson. A commentary and corollary on Prof. Weighton's paper before the Inst. of Naval Archts. Considers the ways the total cost per unit generated is affected by the condensers. 1400 w. Elec Rev, Lond—June 15, 1906. No. 77477 A.

Draft.

Draft. Discusses the removal of the gaseous products of combustion, and the supplying of the proper amount of oxygen.. Considers mechanical draft and when it is desirable. 3000 w. Power—July, 1906. No. 77525 C.

Economy Test.

Economy Test of a Skinner Engine. Reports a test made by Prof. R. C. Carpenter under actual running conditions, giving the results. 1500 w. Power—July, 1906. No. 77523 C.

Engine Economy.

Engine Economy as Affected by Unequal Cut-off. Thomas Hall. Investigations which tend to show that it is not necessary from the point of economy to have exactly equal adjustment of the cards for both ends of the cylinder, throughout the full range of cut-off. 1500 w. Power—July, 1906. No. 77517 C.

Engines.

Rebuilding a Large Rolling Mill Engine. An illustrated description of the compounding of an engine in the South Works of the Illinois Steel Co., the success of the work of installation and the remarkable record made in the time of installation. 1500 w. Engr, U S A—June 15, 1906. No. 77366 C.

Entropy.

The Practical Aspect of Entropy. J. H. Hart. An explanation of the meaning and importance of entropy by analogy with other physical and mechanical relations. 3000 w. Enginering Magazine—July, 1906. No. 77687 B.

Feed Water.

The Art of Water Softening. C. Herschel Koyl. General discussion of the subject, and brief consideration of the lime treatment, the soda treatment, and the mechanical treatment. 2000 w. R R Gaz—June 8, 1906. No. 77225.

Lubricator.

The Gravity Light-Feed Lubricator. Paul D. Phillips. Explains the working of a gravity lubricator, and the care needed. Ills. 1000 w. Power—July, 1906. No. 77520 C.

Pipes.

Some Facts About Steam Pipe Lines. Walter E. Dixon. Points of importance in the erection of steam pipe lines; the expansion and contraction, joints, leakage, etc. 1700 w. Power—July, 1906. No. 77524 C.

Some High-Pressure Steam Pipe Details. James Acton Miller. An illustrated discussion of wrought pipe, the bends, joints, welds, etc. 2500 w. Cassier's Mag—June, 1906. No. 77296 B.

Smoke.

Electricity and Gas V. Smoke. C. Alfred Smith. Principally a review of A. J. Martin's lecture before the Society of

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Arts. 1800 w. Elec Rev, Lond—May 25, 1906. No. 77127 A.

Staybolts.

Concerning Staybolts. A discussion of the design and material of staybolts, quoting from various investigators, and giving tables of valuable data. 4500 w. Locomotive—April, 1906. No. 77426.

Superheating.

A New Form of Locomotive Superheater. Illustrated description of an application of the Notkine superheater to the locomotive boiler. 600 w. Ry & Engng Rev—June 16, 1906. No. 77354.

Remarkable Efficiencies in Small Engines Using Superheated Steam. R. E. Mathot. Gives results obtained in a test upon a Wolf engine of 40 h. p. working with superheated steam. Ills. 1500 w. Power—July, 1906. No. 77518 C.

Turbines.

Some Practical Experiences with Steam Turbines. C. E. Stanton. Read before the Iowa Elec. Assn. Considers step-bearing pumps, bafflers, strainers, valves, nozzles, lubrication, etc. 2800 w. Sci Am Sup—June 2, 1906. No. 77045.

The Present Status of the Steam Turbine. Reviews a report presented at the recent meeting of the National Electric Light Assn., giving results of investigations during the past year into the development of steam turbines and their maintenance. 5400 w. Eng Rec—June 16, 1906. No. 77338.

MISCELLANY.

Damascening.

Damascening and the Inlaying and Blending of Metals. Sherard Cowper-Coles. An introductory historical sketch of this art, describing the processes used in ancient times, and also of a new process and its results. Discussion. Ills. 5400 w. Jour Soc of Arts—June 1, 1906. No. 77182 A.

Inventing.

The Art of Inventing. Edwin J. Prindle. Remarks on this subject, with an illustrated description of how the cord knotter of the self-binding harvester was invented. 2200 w. Sci Am—June 23, 1906. No. 77419.

Liquid Air.

Liquid Air and Charcoal at Low Temperature. An account of an experimental discourse demonstrating some novel features of studies on liquid air and the application of charcoal at low temperatures. 2500 w. Engng—June 15, 1906. No. 77488 A.

Tinning.

Tinning. Translated from the German of Friedrich Hartmann's "Das Verzinnen, Verzinken, Vernickeln, etc. Discusses the process, the testing of tin, alloys used as substitutes, etc. 1800 w. Sci Am Sup—June 23, 1906. No. 77421.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Falls of Roof and Coal. Gives the recommendations issued by the Prussian Commission, with a view to preventing accidents. 900 w. Col Guard—May 25, 1906. No. 77136 A.

Africa.

The Geology of the Komati Poort Coal-Field. H. Kynaston. Abstract from the Trans. Geol. Surv. Repts. Description with report of full tests. 2000 w. Min Jour—June 16, 1906. No. 77472 A.

Bituminous.

Mine No. 2, St. Louis & O'Fallon Coal Co. Illustrated description of the equipment of a new bituminous coal mine of large capacity, near Belleville, Illinois. 2500 w. Mines & Min—June, 1906. No. 77183 C.

Briquettes.

Artificial Fuel. From the German of Dr. Theodor Koller. Mentions some attempts made to prolong the burning of coal, and especially describes in detail the manufacture of briquettes. 3300 w. Sci Am Sup—June 16, 1906. No. 77287.

British Columbia.

The Northern Interior Plateau Lying Between the Fraser and Skeena Rivers. W. F. Robertson. Extracts from a report giving information of this region, its minerals, principally coal, agricultural posibilities, etc. Ills. 9600 w. B C Min Rec—April, 1906. No. 77190 B.

Coal Testing.

Coal Testing Plant Report. Samuel Sanford. A review of the results accomplished by the plant at the St. Louis Exposition. 4300 w. Mines & Min—June, 1906. No. 77188 C.

Coke.

By-Product Coke and Huessener By-Product Coke Ovens. J. A. Roelofsen. Read before the British Inst. of Min. Engrs. Illustrates and describes these ovens stating the advantages claimed. 2500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77494 A.

Domestic Coke Manufacture. F. W. Parsons. Gives a sketch showing the general arrangement of a domestic coke plant capable of producing 50 to 100 tons per day, at comparatively small outlay.

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600 w. Eng & Min Jour—June 16, 1906. No. 77311.

Electrically-Operated Coke-Drawing Machines. Frank C. Perkins. Illustrations showing details of construction and method of operating of a plant at Uniontown, Pa. 1500 w. Elec Engr, Lond—June 1, 1906. No. 77265 A.

Culm.

The Culm-Handling Plant at the Queen Louisa Coal Mines at Zabrze, Upper Silesia (Die Einführung des Sandspülversatzes auf dem Staatlichen Steinkohlenbergwerk Königin Luise bei Zabrze, O. S.). H. Arbenz. An illustrated account of methods of handling and disposing of the spoil in the coal mines of Silesia. 10000 w. 6 plates. Glückauf—May 19, 1906. No. 77627 B.

Indian Territory.

Oil, Coal, and Gas in the Muscogee Quadrangle, Indian Territory. Reliable information of this portion of the territory. 1500 w. Min Rept—June 7, 1906. No. 77209.

New Mexico.

Carboniferous Coal Measures in the Southwest. Charles R. Keyes. Information concerning coals of true Carboniferous age, recently discovered in New Mexico. 600 w. Eng & Min Jour—June 16, 1906. No. 77309.

Rescue.

The Organization and Training of Rescue Brigades. H. Meyer, in *Glückauf*. Considers the training of men in the use of the regenerative type of apparatus. 2200 w. Col Guard—May 25, 1906. No. 77135 A.

Tioga County.

A Brief History of Mining in Tioga County, Pennsylvania. Anton Hardt. From an address before the Historical Society at Wellsboro, Pa. Gives facts showing how much prosperity is due to the coal deposits. 2700 w. Mines & Min—June, 1906. No. 77184 C.

COPPER.

Arizona.

The Olive and Mineral Hill Camps of Pima County, Arizona. A descriptive account of the camps of this district, and the copper and lead-silver ores. 3300 w. Min Rept—May 31, 1906. No. 77089.

Fusing Point.

Notes on he Solidification of Copper (Remarques sur la Solidification du Cuivre). P. Dejean. A record of experimental researches, showing that pure copper solidifies at 1085 degrees C. 5000 w. Revue de Métallurgie—May, 1906. No. 77666 H.

Japan.

The Copper Mines of Japan. Illustrations and information concerning the mines, and their workings, production, etc. 1000 w. Eng & Min Jour—June 2, 1906. No. 77078.

New Jersey.

The Copper Deposits of New Jersey. N. S. Keith. Principally an illustrated description of the Schuyler mine at Arlington, and the Pahaquarry mine and property. 3000 w. Min Mag—June, 1906. No. 77328 C.

GOLD AND SILVER.

Africa.

Experimental Work in African Gold Mines. George E. Walsh. Describes new methods of grinding, and application of the cyanide process, filter pressing, etc. 2500 w. Mines & Min—June, 1906. No. 77186 C.

Rand Metallurgical Practice and Recent Innovations. G. A. and H. S. Denny. A brief outline of the work showing the direction and to what results the work leads. Also discussion. 9000 w. Jour S African Assn of Engrs—April, 1906. No. 77396 F.

ENG MAG—GAL 19

Routine Assaying on the Rand. A. Whitby. Remarks on the importance of the work in the mine assay office, with a sketch plan of a serviceable building for a 200-stamp mill, the equipment, the actual work of assaying, etc. Short discussion. 7000 w. Jour of Chem, Met, & Min Soc of S Africa—March, 1906. No. 77397 E.

Amalgamation.

The Amalgamation of Gold Ores. Thomas T. Read. Explains the nature of an amalgam, and discusses the amalgamation process and the influence of temperature. Ills. 10000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77177 D.

Assaying.

Gold Bullion Assaying. A. Douglas. Read at Melbourne, April 4, 1906. A detailed description of the work. 2500 w. Aust Min Stand—May 9, 1906. No. 77257 B.

Australia.

The Associated Gold Mines of W. A. Donald Clark. A summary of recent metallurgical progress in Kalgoorlie. 2000 w. Aust Min Stand—May 16, 1906. Serial. 1st. part. No. 77467 B.

California.

Gold Veins in Granite in California. W. H. Storms. Describes the characteristics of these gold-bearing veins. 3200 w. Min & Sci Pr—May 26, 1906. No. 77095.

Dredger.

The Robinson Gold-Dredger. Illustrates and describes a new gold-dredger of simple design, and its working. 1700 w. Engng—May 25, 1906. No. 77141 A.

Formosa.

The Gold Mines of Formosa. Acting Consul Crowe. An account of the mining since 1890, with information concerning the most important mines. 1200 w. Min Jour—June 2, 1906. No. 77267 A.

We supply copies of these articles. See page 799.

Hydraulic Mining.

Hydraulic Mining in a Cold Climate. J. P. Hutchins. A discussion of this method of mining and its problems, especially in relation to its use in the Klondike and other northern places. Ills. 4500 w. Min & Sci Pr—June 2, 1906. No. 77211.

Mexico.

Pachuca. H. E. West. Illustrates and describes this district which is a producer of precious metals. 3300 w. Min & Sci Pr—May 26, 1906. No. 77094.

The Taviche District, Mexico. Kirby Thomas. Describes the development of this mining camp, about 23 miles south of Oaxaca. Copper, gold and silver are produced. 2300 w. Min Wld—June 16, 1906. No. 77352.

Milling.

Milling Practice at the Dives-Pelican and Seven-Thirty Company's Concentrating Mill, Silver Plume, Colorado. Describes a mill designed to treat ore carrying a small percentage of high grade mineral and requiring fine grinding. 1500 w. Min Rept—June 7, 1906. No. 77208.

Placers.

Mergers in Placer Mining. J. P. Hutchins. Discusses benefits from merging, and the recent merger in dredge-mining operations. Ills. 2300 w. Eng & Min Jour—June 23, 1906. No. 77457.

Prospecting.

A Few Hints to Prospectors. Charles A. Bramble. Suggestions especially for prospecting work in the north of Canada and British America. 2000 w. Can Min Rev—June, 1906. No. 77363 B.

Sampling.

Note on the Sampling of Gold Alloys. Ernest A. Smith, in *Chemical News*. Information concerning the assaying of various gold alloys used by jewellers and goldsmiths, with tables of assays made. 1700 w. Min Rept—June 14, 1906. No. 77356.

Procedure to be Used in the Sampling and Settling of Ores Shipped to the U. S. Reduction & Refining Co. A copy of the sampling regulations recently issued, with editorial comment. 1600 w. Min Rept—May 31, 1906. No. 77088.

Silver Mill.

A Wet Silver Mill at a Montana Mine. Robert B. Brinsmade. Illustrates and describes the construction of the mill, the machinery used, and method of treating the ore. 5500 w. Mines & Min—June, 1906. No. 77187 C.

Slimes.

The Homestake Slime Plant. H. J. Baron. Describes a plant under construction for the economical cyanidation of gold-carrying slimes by filter pressing. 1400 w. Min Rept—June 21, 1906. No. 77462.

The Parrish Continuous Filter. Edward Parrish. Illustrations with description of a design for a continuous slime filter. 700 w. Eng & Min Jour—June 2, 1906. No. 77079.

Stamp Mills.

More Notes on Stamp Mill Practice. Courtenay de Kalb. Read before the Can. Min. Inst. Statements from experience, considering screens, foundations, stamp duty, mortar liners, shoes and dies, etc. 3000 w. Can Min Rev—June, 1906. No. 77365 B.

Timiskaming.

The Paragenesis of the Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming. W. Campbell and C. W. Knight. Aims to determine the order in which the minerals which go to make up this ore, in Ontario, have been deposited, and to investigate the relation which the gangue bears to them. Ills. 2500 w. Eng & Min Jour—June 9, 1906. No. 77197.

IRON AND STEEL.

Bins.

Coke and Ore Bins. J. W. Pittman. Considers their construction, size, types, etc. General discussion and illustrations. 2800 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77300 D.

Charging Machines.

Recent Improvements in Combined Ingot Strippers and Vertical Charging Machines. Drawings and description of alterations and improvements introduced. 1600 w. Ir & Coal Trds Rev—June 1, 1906. No. 77273 A.

Dry-Air Blast.

Notes on the Gayley Dry-Air Blast Process. C. A. Meissner. A further discussion of the paper of James Gayley, with special reference to his supplementary paper, and to the paper of J. E. Johnson, Jr. Also discussion. 14000 w. Bul Am Inst of Min Engrs—May, 1906 No. 77174 D.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Handling.

The Handling and Conveying of Furnace Material (Zur Frage der Bewegung und Lagerung von Hüttenrohstoffen). M. Buhle. Describing various forms of dump cars, conveyors, unloaders, especially arranged for handling iron ore, etc. 3500 w. Stahl u Eisen—June 1, 1906. No. 77631 D.

Ingots.

Piping in Steel Ingots. N. Lilienberg. Considers the processes invented to obviate piping, and gives an illustrated description of the Illingworth casting machine. 2500 w. Bul Am Inst of Min Engrs—May, 1906. No. 77171.

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Iron Mining.

Iron Mining on a Big Scale. From the *Mining Gazette*, Houghton. Remarks on the indications for a large demand, and the rapid work in progress on the Mesabi and Vermilion ranges. 1800 w. Min & Sci Pr—June, 1906. No. 77361.

Iron Ore.

Iron Ores Reserves. Charles Kenneth Leith. Showing that current estimates point to a short life for iron ore reserves, but that these estimates are low, and that low grade ore is not sufficiently considered. 2800 w. Can Min Rev—June, 1906. No. 77364 B.

Mining Soft Iron Ore Without Timber. Stuart Rhett Elliott. Describes a method of mining applicable to a variety of ore that drills easily, breaks and runs freely, yet is hard enough to stand for a considerable time over a large opening. 1200 w. Min & Sci Pr—June 9, 1906. No. 77358.

Manganese.

The Manganese Industry in India. Ralph Stokes. Illustrated article giving information of this industry, the deposits, working, etc. 1400 w. Min Wld—June 16, 1906. No. 77351.

Mine.

The Forest of Dean Iron Mine. An account of a historic property in Orange Co., N. Y., with illustrated description of the new equipment and work of reopening the mine. 2000 w. Ir Age—June 21, 1906. No. 77405.

Open Hearth.

The Chemical Action of the Acid Open-Hearth Furnace (Action Chimique du Four Martin Acide). M. Deslandes. Examining successively the behavior of the silicon, manganese, sulphur, phosphorus, and nickel, as observed in furnaces at the Schneider works. 3500 w. Revue de Métallurgie—June, 1906. No. 77669 H.

Rolling.

Improvements in Rolling Iron and Steel. James E. York. Explains the difficulties met in roll-designing, and gives an illustrated detailed description of the York universal mill, for rolling sections with wide flanges and their webs, or the usual sections, explaining its advantages. Also considers the making of steel ties. 4000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77172 C.

Smelting.

Official Preliminary Report of the Dominion Government, on the Experiments Made at Sault Ste. Marie, in the Smelting of Canadian Iron Ores by the Electro-thermic Process. Describes the furnace and electric holder, electrical machinery, experiments, etc., giving a summary of the results. 5000 w. Can Engr —June, 1906. No. 77191.

Steel Plant.

U. S. Steel Corporation's Great Plant at Gary, Ind. Diagram and description of a plant under construction at the extreme southern end of Lake Michigan. 3000 w. Ir Trd Rev—June 21, 1906. No. 77399.

MINING.

Costa Rica.

Mineral Deposits of Costa Rica. Francis C. Nicholas. An illustrated account of this island, reporting a well defined gold region, promising copper prospects, and an immense deposit of iron sand. 800 w. Min Wld—June 16, 1906. No. 77353.

Deep Mining.

Considerations on Deep Mining. George Farmer. Read before the British Inst. of Min. Engrs. Discusses high temperature, increased ventilation, working, pressure, lighting, explosives, mechanical appliances, winding, etc. 4500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77495 A.

Disaster.

The Catastrophe at Courriéres (La Catastrophe de Courriéres). E. Lemaire. A discussion of French legislation relating to the responsibility in cases of accidents in mines, with especial reference to the disaster at Courrières. 3500 w. Génie Civil—April 28, 1906. No. 77609 D.

The Disaster at the Courrières Mine (La Catastrophe des Mines de Courrières). E. Lemaire. A review of the entire situation at the Courrières Mine near Lens, France, describing the workings and the disaster of March 10, 1906. 3000 w. Génie Civil—April 21, 1906. No. 77607 D.

Electrical Machinery.

Experiments at Gelsenkirchen with Electrical Appliances for Fiery Mines. Bergassessor Beyling, in *Glückauf*. Gives a summary of the interesting conclusions from these experiments. 2000 w. Col Guard—May 25, 1906. No. 77134 A.

Freezing.

The Development of the Freezing Process Since its Introduction in 1883 (Die Entwricklung des Gefrierverfahrens seit seiner Ersten Anwendung im Jahre 1883). H. J. Joosten. A long tabulated account of various shafts sunk through quicksand by the aid of the Poetsch freezing process. 10000 w. Glückauf—June 2, 1906. No. 77630 B.

Haulage.

Notes on Top and Bottom Endless Rope Haulage on Curves at Bedlington Collieries. E. Graham. Read before the Nat Assn. of Colliery Mgrs. Illustrated description of the methods adopted. Discussion. 4000 w., Ir & Coal Trds Rev—June 8, 1906. No. 77394 A.

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Joplin.

Joplin Re-visited. F. Lynwood Garrison. Notes on the changes in this lead and zinc district during the last six years. Ills. 2000 w. Min & Sci Pr—May 26, 1906. No. 77092.

Kaolin.

A Novel Method of Mining Kaolin. Albert R. Ledoux. Describes the method adopted by Mr. M. Wanner, at West Cornwall, Conn., for mining kaolin from deep deposits without shaft-sinking or removing of the overburden. 900 w. Bul Am Inst of Min Engrs—May, 1906. No. 77173.

Machine Mining.

Electrically-Driven Air-Compressors Combined with the Working of the Ingersoll-Sergeant Heading-Machines and Subsequent Working of the Busty Seam at Ouston Colliery. A. Thompson. Read before the British Inst. of Min. Engrs. Describes the work and compares the results and costs with hand labor. 3500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77491 A.

Labor-Saving Machinery in Coal Mining. F. W. Parsons. Deals with the advances made in the mechanical handling of coal both under and above ground. 1700 w. Eng & Min Jour—June 16, 1906. No. 77312.

Practical Problems of Machine Mining. Sam Mavor. Read before the British Inst. of Min. Engrs. A brief review of a lengthy paper covering practically the whole field of machine mining. 1000 w. Ir & Coal Trds Rev—June 15, 1906. No. 77492 A.

Mine Workings.

A Reference Scheme for Mine-Workings. Wilbur E. Sanders. Explains the need and gives a reference scheme for numbering and naming points and parts of mine-workings. Plans. 3000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77170.

Nevada.

Manhattan. A. H. Halloran. An illustrated report of this mining district in Nevada, with a criticism of methods that have been tried to attract capital. 1800 w. Min & Sci Pr—June 9, 1906. No. 77359.

Ore Deposits.

The Practical Importance of Geology in the Study of Ore Deposits. John D. Irving. Aims to show that the geological relations of ore-deposits are the relations upon which the success of the metallurgical operations, the mining operations, and the accuracy of an estimate of the mineral wealth depend. 4000 w. Yale Sci M—June, 1906. No. 77371 C.

Pay-Streaks.

Following the Pay Streak. R. B. Nickerson. Describes the experience of a mine superintendent, and the difficulties encountered. 2300 w. Min & Sci Pr—June 9, 1906. No. 77360.

Quarries.

Wealth in Barre Granite. Alton D. Adams. An illustrated description of the large quarries at Barre, Vermont, and the methods of quarrying. 1700 w. Mines & Min—June, 1906. No. 77185 C.

Respirators.

Modern Improvements in Life-Saving Apparatus (Bericht über Versache mit Rettungsapparaten und über deren Vekbesserungen). H. Grahn. An account of tests with artificial respiration apparatus at the Shamrock shaft of the Hibernia mine in Westphalia. 6000 w. Glückauf—May 26, 1906. No. 77629 B.

Rock Pressures.

Rock Pressures as the Cause of the Fall in the Pribram Mines (Spannungen im Gesteine als Ursache von Bergschlägen in den Pribramer Gruben). Hugo Stefan. Reviewing several falls of rock in the Pribram mines in Bohemia, probably due to the pressure in the rock. 2000 w. Oesterr Zeitschr f Berg u Huttenwesen—May 19, 1906. No. 77626 D.

Shafts.

Misplacement of Shafts. E. J. Dunn. Concerning the Bendigo field, and the survey being made which will be a valuable guide to the correct position of future shafts. 1000 w. Aust Min Stand—May 9, 1906. No. 77256 B.

Sizing.

Screens for Sizing. Ernest A. Hersam. Gives tables of use in arranging a graded series of screens, following any mathematical law or the line of any curve, with remarks bearing on this subject. 7000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77175 C.

Tube Mills.

Notes on Tube-Mills at El Oro, Mexico. Charles Butters. Notes on the operation of tube-mills at El Oro, with suggestions. 2000 w. Min & Sci Pr—May 26, 1906. No. 77093.

Tube-Mill Practice. W. R. Dowling. Discussing points of practical interest to those engaged in tube-mill work. Briefly describes the tube-mill equipment of the Robinson Deep G. M. Co. 5000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1906. No. 77398 E.

Veins.

The Evolution of a Mineral Vein. Arthur Lakes. An illustrated description of a mineral vein showing its geological features. 700 w. Min & Sci Pr—May 26, 1906. No. 77096.

Ventilation.

Some Examples of Modern Mine Ventilation. Describes the various methods now being employed in some of the northern counties of England and gives

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facts concerning the ventilating plants installed. Ills. 2500 w. Ir & Coal Trds Rev—June 8, 1906. No. 77395 A.

Winding.

Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work. W. C. Mountain. Read before the British Inst. of Min. Engrs. Gives tables showing the actual cost of winding by steam engines, and by electricity, and much information. 6800 w. Ir & Coal Trds Rev—June 15, 1906. No. 77490 A.

Electric Hoisting at the Noel-Sart-Culpart Collieries. Alfred Gradenwitz. Illustrated description of the plant installed in these mines in Belgium. 2000 w. Eng & Min Jour—June 9, 1906. No. 77199.

Steam Hoisting Engines (Ueber Dampf förder maschinen). Data and results of tests on hoisting engines, with indicator and load diagrams. 4000 w. Glückauf—May 19, 1906. No. 77628 B.

The Failure of Winding Ropes. E. King. An illustrated description of the "Kilindo" rope construction, and remarks on its wearing qualities. 1000 w. Min Jour—May 26, 1906. No. 77132 A.

MISCELLANY.

Diamonds.

The Diamond Mines of South Africa. Gardiner F. Williams. An interesting illustrated account of these mines, the miners, methods, etc. 3500 w. Nat Geog Mag—June, 1906. No. 77373 C.

Lead and Zinc.

The Wisconsin Lead and Zinc District. An illustrated description and historical review of this district. 2500 w. Eng & Min Jour—June 23, 1906. No. 77456.

Metals.

The Metals in Human Progress. Nelson P. Hulst. An interesting study of the use of metals as influencing the progress of civilization. 3000 w. Sci Am Sup—June 16, 1906. Serial. 1st part. No. 77289.

Mineral Earths.

Mineral Earths in South Dakota. Denis Henault. Concerning these deposits, especially of fuller's earth and volcanic ash. Min Rept—June 7, 1906. No. 77210.

Separation.

The Present Status of the Separation of Zinc Blende in Copper and Lead Ores. R. C. Canby. A review of the processes and devices used, and the advance made. 2200 w. Min Mag—June, 1906. No. 77329 C.

Sulphur.

Determination of Sulphur in Pyrites. C. R. Gysander, in *Chemical News*. Describes the hydroxylamine method, and compares the results obtained with the Lunge method. 100 w. Min Rept—June 14, 1906. No. 77357.

Tin.

A Volumetric Method for Tin. James Darroch and C. A. Meiklejohn. Describes a volumetric method, for estimating tin, which gives good results, and is applicable to all ores of the metal, and an assay may be completed in an hour. 800 w. Eng & Min Jour—June 23, 1906. No. 77455.

Brookstead Tin Field. H. Grant. A review of the development of the Brookstead lode, in North-eastern Tasmania, showing the richness of the field, and the importance of thorough prospecting. 2000 w. Aust Min Stand—June 6, 1906. No. 77875 B.

Substitutes for Tin. L. Parry. The recent shortage of the tin supply makes it wise to consider the question of substitutes, and the principal uses to which the metal is applied are discussed and how far other metals could take the place of tin. 2000 w. Min Jour—June 2, 1906. No. 77268 A.

Tin Deep Leads in Selangor. H. Herbert Noyes. Information concerning the deep leads of Malay Peninsula, and the peculiarities of Chinese miners. 1500 w. Min Jour—May 26, 1906. No. 77133 A.

Zinc.

Milling in Southwest Wisconsin. George S. Brooks. Concerning the methods of concentration in the zinc fields of the Upper Mississippi, describing the deposits and giving plan of the concentrator plant. 2200 w. Eng & Min Jour—June 16, 1906. No. 77310.

Notes on a Mill Test. Benjamin Hodge. Reports a test made on a small zinc mill in the Wisconsin district, showing high efficiency. 1200 w. Min Mag—June, 1906. No. 77330 C.

The Zinc Industry in the United States. H. S. Clark. The conditions in the different districts, the methods of mining, treatment, etc., and the inventions used in the different fields are considered. 3800 w. Min Mag—June, 1906. No. 77327 C.

Zinc and Lead Deposits in Wisconsin. U. S. Grant. Information concerning the geology, ore deposits, mining and concentrating, and prospecting. Ills. 3000 w. Min Mag—June, 1906. No. 77326 C.

Zinc Ore in Northern New York. D. H. Newland. Describes deposits in St. Lawrence County, giving map and information of interest. 1000 w. Eng & Min Jour—June 9, 1906. No. 77198.

Zinc-Ore Mining in Wisconsin. A review of the development since 1902, when the application of magnetic separation removed the iron sulphide from the zinc blende. Details of shaft-sinking, pumping and mining are given, with map of the Enterprise mine. 3000 w. Eng & Min Jour—June 30, 1906. No. 77743.

See Electrical Engineering, Electro-Chemistry.

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CONDUCTING TRANSPORTATION.

Long Island.

Long Island Railroad. Considers the last report for the year ending Dec. 31, 1905, and the causes of the great increase in expenses. 1600 w. R R Gaz—June 8, 1906. No. 77218.

Motive Power.

The Motive Power Officer. G. M. Basford. An address delivered before the Mechanical Engineering Society of Purdue University. Explains the possibilities of the motive power problem, and some of the questions motive power men must decide. 4800 w. Ry Age—June 8, 1906. No. 77202.

Performance.

Locomotive Performance Sheets. H. H. Vaughan. Describes the sheets in use on the Canadian Pacific, discussing the advantages of their arrangement. 2000 w. Am Engr & R R Jour—June, 1906. No. 77114 C.

MOTIVE POWER AND EQUIPMENT.

Brake Beams.

Brake Beams for 60,000, 80,000, and 100,000-lb. Freight Cars. Report of the Committee of the Master Car Builders' Assn. 3500 w. Eng News—June 14, 1906. No. 77437.

Car Ferries.

Car Ferry Lines of American Railroads. Gives statistics of lines operated by 35 companies, and illustrations, with description of methods and other information. 3300 w. R R Gaz—June 8, 1906. No. 77227.

Car Heating.

Mixed System of Heating Railway Trains by Steam and Water (Chauffage des Trains par la Vapeur et l'Eau Combinées). H. Guérin. A description of the Baudry system, used on the Paris-Lyons-Mediterranean line. Radiators containing water are heated by a circulation of steam. 2500 w. 1 plate. Génie Civil—May 12, 1906. No. 77614 D.

Car Lighting.

McElroy Automatic Car-Lighting System. This electric car-lighting system is illustrated and described in detail. 1500 w. R R Gaz—June 8, 1906. No. 77226.

The "Vickers-Hall" System of Electric Lighting for Railway Carriages. Illustrated detailed description of this system and its action, stating the advantages claimed. 2500 w. Elec Rev, Lond—June 1, 1906. No. 77266 A.

Cars.

Box Car with Hatches for Loading and Unloading Through the Roof: Tehuantepec National Railway, Mexico. Sectional plan, sectional side elevation with brief description and dimensions. 400 w. Eng News—June 21, 1906. No. 77412.

Freight-Car Construction and Its Commercial Aspect. L. H. Turner. A discussion of some of the weak points in car construction. 1500 w. Am Engr & R R Jour—June, 1906. No. 77116 C.

New Types of Goodwin Car. Illustrated description of a new design of flat bottom gondola dumping cars, having unusually large discharge openings. 1000 w. Ry & Engng Rev—June 9, 1906. No. 77213.

One Hundred Ton Capacity Flat. Illustrations, sections, and description of the car built for the Allis-Chalmers Co. 1000 w. Ry & Loc Engng—June, 1906. No. 77104 C.

Phosphate Cars for the Atlantic Coast Line. Illustrated description of a combination of a box car and a center dump hopper car, having a capacity of 80,000 lbs. 600 w. R R Gaz—June 8, 1906. No. 77222.

Standard All-Steel 60-Ft. Postal Car for the Harriman Lines. Drawings and description. 600 w. R R Gaz—June 22, 1906. No. 77447.

Standard 80,000-lb. Box Car for the Rock Island-Frisco System. Drawings and description of the standard design for a box car. 900 w. R R Gaz—June 8, 1906. No. 77219.

The 50-Ton Box Car as a Standard in Railroad Equipment. W. E. Symons. Discussing whether the results obtained from the use of the 50-ton car in actual service will justify its extended use in all localities as a standard car, in place of the 40 or 30-ton car. 3000 w. R R Gaz—June 8, 1906. No. 77220.

Draft Gear.

American Engineer Tests on Locomotive Draft Appliances. Committee report of the results of tests carried out, and the methods. 3000 w. Am Engr & R R Jour—June, 1906. No. 77119 C.

Friction Draft Gear on Cars and Locomotives. W. O. Thompson. Gives examples showing the importance of high cushion resistance, considers the measures of efficiency, and the different kinds of draft gear tests, etc. General discussion. Ills. 18000 w. Pro Cent Ry Club—May 11, 1906. No. 77293 C.

Electricity.

Report of Committee of American Railway Master Mechanics' Association on Electricity on Steam Railroads. 3000 w. Ry & Loc Engng—June, 1906. No. 77446 C.

Headlights.

Oil vs. Electric Headlights. S. A. Abbott. Read before the Int. Gen. Foremen's Assn. Sets forth the advantages claimed for the electric headlight. 1700 w. Ry & Loc Engng—June, 1906. No. 77106 C.

Locomotives.

Balanced Compound Locomotives. H. V. Wille. An illustrated article discussing features of these engines, which the writer considers the highest type produced. 1800 w. R R Gaz—June 15, 1906. No. 77281.

Baltimore & Ohio Railroad Motive Power. Descriptions and Illustrations of recent types of steam and electric freight, passenger and switching locomotives. 1500 w. R R Gaz—June 15, 1906. No. 77278.

Care and Maintenance of Freight and Passenger Engines at Terminal to Give Maximum Mileage and Efficient Service. E. T. James. A detailed consideration of this subject, followed by general discussion. 12700 w. Pro N Y R R Club—May 18, 1906. No. 77291.

Consolidation Locomotive for the New York Central Lines. An illustrated detailed description, with dimensions. 1200 w. R R Gaz—June 15, 1906. No. 77277.

De Glehn 4-4-2 on the Pennsylvania. Illustration, with brief description of a compound engine built in France. It is of the Atlantic type and fitted with Walschaert valve gear. 600 w. Ry & Loc Engng—June, 1906. No. 77105 C.

Fairlie Locomotive for the Bolivian Railways (2-ft. 6-in. Gauge). Illustrated description with principal dimensions. 900 w. Engng—June 8, 1906. No. 77387 A.

4-6-2 Passenger for the N. & W. An illustrated description of a single expansion 4-6-2 engine for the Norfolk & Western, for passenger service. 900 w. Ry & Loc Engng—June, 1906. No. 77103 C.

Lake Shore Heavy Passenger Locomotive. Illustrations, with dimensions of a 2-6-2 engine, said to be the heaviest passenger locomotive ever built. 400 w. Ry Age—June 1, 1906. No. 77085.

Latest Express Engines—Southeastern and Chatham Railway. Charles Rous-Marten. Illustrated description and dimensions of the latest design of Mr. Harry S. Wainwright, and an account of the work they are expected to perform is given in the present number. 2200 w. Engr, Lond—June 8, 1906. Serial. 1st part. No. 77389 A.

New York Central Electric Locomotives. Reginald Gordon. Presents a detailed description of these locomotives. Ills. 2000 w. R R Gaz—June 15, 1906. No. 77282.

Pacific Locomotive for the Southern Railway. Illustrated description of recently built (4-6-2) locomotives for passenger and fast freight service. 500 w. R R Gaz—June 29, 1906. No. 77537.

Pacific Type Passenger Locomotives. Remarks on this type of engine, illustrating the two kinds of trailing trucks used, and giving a table of the principal dimensions of several Pacific type passenger locomotives. 1500 w. Ry Mas Mech—June, 1906. No. 77181.

Prairie Type Passenger Locomotive with Walschaert Valve Gear. Illustrated description of a type of heavy passenger engines which are in service on the L. S. & M. S. Ry. 900 w. Am Engr & R R. Jour—June, 1906. No. 77113 C.

Recent Baldwin Locomotives. Illustrations of a 2-8-2 and a 2-6-2 type,with brief descriptions. 600 w. Ry Age—June 8, 1906. No. 77204.

Recent Development of American Passenger Locomotives. George L. Fowler. An interesting illustrated review of locomotive development. 3000 w. R R Gaz—June 15, 1906. No. 77280.

Simple Consolidation Locomotive with Walschaert Valve Gear. Illustrated description of the design known as Class H 6 B, for use on the Pennsylvania R. R. 800 w. Am Engr & R R Jour—June, 1906. No. 77120 C.

Simple Four-Cylinder Passenger Locomotive with Superheater. Illustrated description of a heavy, balanced, ten-wheel engine for the Belgian State Railways. 1500 w. Am Engr & R R Jour—Jur :, 1906. No. 77117 C.

Some Recent Designs of Tank Locomotives. Photographs and particulars of three different types designed for specified service. 1200 w. Mech Engr—June 2, 1906. No. 77260 A.

The Development and Present Status of the Compound Locomotive in the United States. Editorial review of the history of the compound locomotive in the United States, with discussion of the work for which it is suited. 2000 w. Eng News—June 21, 1906. No. 77416.

Motor Cars.

A New Steam Rail Motor Car. Illustrated description of a new design with a statement of the advantages claimed. The car is built by James T. Halsey, Philadelphia. 1200 w. R R Gaz—June 8, 1906. No. 77228.

A Petrol-Electric Rail Motor Car. Illustrates and describes an interesting type of petrol-electric motor car introduced by De Dion Bouton, Ltd. 1000 w. Tram & Ry Wld—June 7, 1906. No. 77401 B.

Benzine-Electric Railway Motor Car. (Benzinelektrische Selbstfahrer im Eisenbahnbetriebe). Jaromir Krizko. A combination railway motor car, with a dynamo driven by a combustion engine, delivering current to electric motors on

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the axles. Data and results of operative tests are given. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—June 8, 1906. No. 77617 D.

Gasolene Motor Cars. W. R. McKeen, Jr. Describes the motor cars of the Union Pacific Railroad, and reports their performance. 2000 w. R R Gaz—June 15, 1906. No. 77283.

The Esslingen Railway Motor Car (Der Eisenbahnmotorwagen der Maschinenfabrik Esslingen). A. Heller. Describing an independent steam motor-car, with vertical boiler, and superheater, and space for 16 seats, and a luggage compartment. Speeds of 56 kilometers per hour are attained. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 2, 1906. No. 77604 D.

Wheels.

Cast Iron Wheels. Discusses the strength and limit of load for cast iron wheels, the flange, and the rivalry of the steel wheel. 1000 w. R R Gaz—June 8, 1906. No. 77229.

Energy Expended on Car-Wheel Acceleration. Gives a calculation based upon particular specimens of wheel and only approximately accurate for general application. 1200 w. Sci Am Sup—June 2, 1906. No. 77046.

The Chilled Car Wheel from a Manufacturer's Standpoint. P. H. Griffin. Considers the troubles due to cheap wheels, and the bargaining for low prices, which has necessarily affected the quality. 2000 w. R R Gaz—June 8, 1906. No. 77223.

NEW PROJECTS.

Philippines.

New Railways in the Philippines. Percival E. Fansler. Describes present transportation facilities, and the possibilities for railway development, describing also the country through which the proposed roads are to pass. Ills. 4000 w. Cassier's Mag—June, 1906. No. 77297 B.

PERMANENT WAY AND BUILDINGS.

Coaling Station.

A Reinforced Concrete Locomotive Coaling Station of Unusual Construction on the Lehigh Valley Railroad. W. E. Phelps. A new concrete-steel station at South Easton, Pa., is illustrated and described. 1000 w. Eng News—June 14, 1906. No. 77441.

Pennsylvania R. R.

The Pennsylvania R. R. Extension to New York and Long Island: Structural Details of Long Island Power Station. Illustrates and describes in detail the novel and the more important structural features of the power house in Long Island City. 1700 w. Eng News—May 31, 1906. No. 77036.

Rails.

Rail Corrugation. G. Moyle. A technical paper issued by the Indian Government, reporting investigation into the cause of what is termed "roaring rails." Ills. 2000 w. Tram & Ry Wld—No. 77402 B.

Round Houses.

Improved Round House Facilities. J. C. Stuart. Remarks on the problems due to increase in size and weight of locomotives, with illustrated detailed description of the extensive improvements introduced on the Erie Railroad. 1600 w. R R Gaz—June 15, 1906. No. 77279.

Shops.

A Visit to the P., B. & W. Ry. Wilmington Shops. An illustrated article dealing with the most striking features noticed on a recent visit to these shops. 3500 w. Ry & Engng Rev—June 16, 1906. No. 77355.

Locomotive Shop Management. A. W. Wheatley. Offers a suggestion for a uniform classification of repairs, and also for other improvements in shop organization. 1600 w. Am Engr & R R Jour—June, 1906. No. 77118 C.

New Kingsland, N. J., Shops of the D., L. & W. Ry. Illustrated detailed description of recently modernized repair shops and their equipment. 2500 w. Ry & Engng Rev—June 9, 1906. No. 77212.

South Louisville Shops. This first of a series of articles illustrates and describes their general plan and operation. 1500 w. Am Engr & R R Jour—June, 1906. Serial. 1st part. No. 77115 C.

The New Shops of the Canada Car Company, Ltd., at Montreal. A recently completed plant, considered one of the best of the kind on the Continent, is illustrated and described. 3000 w. R R Gaz—June 8, 1906. No. 77224.

Signaling.

All-Electric Interlocking at Council Bluffs. Illustrates and describes a plant under construction on the Union Pacific. 2500 w. R R Gaz—June 8, 1906. No. 77221.

Block and Interlocking Signals in the Electrical Zone of the New York Central & Hudson River R. R. Illustrated detailed description of the extensive all-electric system. 3000 w. Eng News—June 14, 1906. No. 77434.

Block Signal System of the New York Central Electric Zone. The details of this interesting system are illustrated and described. It is known as the "Young System," and seems an important advance in the art of signaling. 3000 w. St Ry Jour—June 9, 1906. No. 77201 C.

The Brierley Fog Signaling Apparatus for Railroads. Illustrates and describes an apparatus being tried on the Great Northern Railway of Great Britain. 1500 w. Sci Am—June 2, 1906. No. 77050.

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Switchbacks.

Switchbacks on the Crown King Extension of the Santa Fé, Prescott & Phœnix Ry. Map, profile and plans, with description. 700 w. Eng News—June 21, 1906. No. 77413.

Terminal.

Victoria Station. Plans and description of reconstruction work of Victoria Station in London, now in progress. 3000 w. Engr, Lond—May 25, 1906. No. 77146 A.

Tracks.

Screw Spikes and Wooden Tie-Plates for Railway Track. Illustrates and describes the Thiollier system of rail fastenings which is in use in Europe, and is being tested by the Pennsylvania Lines. 1700 w. Eng News—June 21, 1906. No. 77415.

Track Elevation at Chicago on the Pittsburgh, Ft. Wayne & Chicago Ry. An illustrated description of the methods employed, which are of interest because of the height to which the tracks were raised, and the narrow space in which the work was done. 1200 w. Eng Rec—June 23, 1906. No. 77428.

TRAFFIC.

Pooling.

Car Clearing Houses and Car Pools—Benefits from Their Establishment. J. W. Midgley. An investigation of the subject of car pools, a car clearing house, an equipment company, and what has been termed a "legal tender" car, with the object of promoting economy and efficiency through the best possible employment of freight cars. 3000 w. Ry Age—June 1, 1906. No. 77084.

Car Pooling—Need of Remedy for Unfair Diversion of Foreign Cars. J. W. Midgley. A discussion of this problem and the difficulties in solving it. 3000 w. Ry Age—June 22, 1906. No. 77463.

Train Operation.

A Graphic Record of Train Operation. Gives a reduced chart made by a recording machine and a statement of the information shown on it. 1500 w. Ry Age—June 8, 1906. No. 77203.

MISCELLANY.

Anniversary.

Seventieth Anniversary of an English Railroad. W. B. Paley. Historical review of the South-Eastern Railway. Ills. 1200 w. R R Gaz—June 1, 1906. No. 77054.

Siam.

Railroads and Transportation in Siam. L. E. Bennett. An illustrated account of the work thus far accomplished, with the history, cost of construction, etc. 3800 w. R R Gaz—June 1, 1906. No. 77053.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Charlottenburg Subway (Die Untergrundbahn in Charlottenburg). P. Koch. With map showing the line from Berlin to the suburb of Charlottenburg, and illustrations of the work and the crossings. 1500 w. Elektrotech u Polytech Rundschau—May 17, 1906. No. 77660 D.

Cars.

Electric Street Cars for City Service. M. B. Starring, and H. B. Fleming. Illustrated detailed description of the Standard car for the Chicago City Railway Co., and its electrical equipment. Discussion. 10000 w. Jour W Soc of Engrs—June, 1906. No. 77504 D.

England.

Blackpool, St. Anne's, and Lytham Tramways. Illustrated description of the construction of these electric tramways, which are remarkable for the "straight runs," freedom from gradients, and small number of curves. 2000 w. Tram & Ry Wld—June 7, 1906. No. 77400 B.

Interurban.

Some Considerations as to Safety in the Operation of Electric Interurban Railways. An editorial review of matters affecting their safe operation, especially dealing with the larger and more important lines. 3300 w. Eng News—June 7, 1906. No. 77244.

The Southern Michigan Railway. Illustrates and describes a new line of electric interurban railways 24 miles in length, connecting St. Joseph and Niles, Mich., and gives an account of present and projected lines. 1700 w. Ry & Engng Rev—June 2, 1906. No. 77086.

Locomotives.

The Electric Locomotives for the Simplon Tunnel (Les Locomotives Electriques du Tunnel du Simplon). Describing and illustrating the new three-phase locomotives being built for the tunnel service by Brown, Boveri & Co. 3500 w. 1 plate. Bull Tech de la Suisse Romande—May 25, 1906. No. 77640 D.

The New Simplon Three-Phase Locomotives. Frank C. Perkins. Diagram and photographs with description of interesting details. 1000 w. Elec Engr, Lond—June 8, 1906. No. 77377 A.

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Long Island.

The Power Transmission Line and Third-Rail System of the Long Island Railroad. W. N. Smith. Begins an illustrated detailed description of this high-tension electric line. 9500 w. St Ry Jour—June 9, 1906. Serial. 1st part. No. 77200 C.

The Power Transmission Line, and Third Rail System of the Long Island Railroad. W. N. Smith. Illustrated detailed description. 6800 w. Elec Rev, N Y—June 9, 1906. No. 77195.

The Rotary Converter Substations of the Long Island Railroad. W. N. Smith. Illustrates and describes the general scheme of power distribution to the several lines through rotary-converter substations. 11400 w. St Ry Jour—June 23, 1906. No. 77445 C.

Transmission and Distribution System, Long Island R. R. Illustrates and describes in detail the more important structural features of the transmission and distribution system. 4500 w. Eng News—June 14, 1906. No. 77433.

Mountain Road.

The Brunnen - Morschach Electric Mountain Railway (Die Elektrische Bergbahn Brunnen Morschach Schweiz). Wolfgang Adolf Müller. The road runs from Brunnen on the lake of Lucerne to Morschach, 258 metres above. It is a rack railroad, with three-phase electric traction; details of the line and locomotives are given. 3500 w. Zeitschr d Ver Deutscher Ing—May 19, 1906. No. 77601 D.

Operation.

A Study of Electric-Railway Operating Cost and Revenue. H. S. Knowlton. A discussion of the applications of the unit basis method of administration, with examples from representative roads. 2500 w. Engineering Magazine—July, 1906. No. 77686 B.

Paris.

The North-South Underground Railway in Paris (Le Chemin-de-fer Electrique Souterrain Nord-Sud de Paris). A. Dumas. A description of the new section of the Paris Metropolitain, connecting the Montparnasse quarter with Montmartre. 3500 w. 1 plate. Génie Civil—April 28, 1906. No. 77608 D.

The Paris Metropolitan Railway (Le Métropolitain de Paris). A. Dumas. A review of the projected extensions of the underground railway in Paris, together with a description of the extensive works now under construction, with maps and profiles. 10000 w. 5 plates. Génie Civil—April 21, 1906. No. 77606 D.

Preliminaries.

Electric Railway Engineering Preliminaries. Sydney W. Ashe. Discusses the relation of trackage and traffic to population, and other matters to be considered in planning a new system of electric railways. 2500 w. Elec Rev, N Y—June 2, 1906. No. 77111.

Report.

Report of Electric Railway Test Commission. Review by Louis Bell, of the report of the Commission which served at the St. Louis Exposition. 2500 w. St Ry Jour—June 2, 1906. Serial. 1st part. No. 77068 C.

Signalling.

Automatic Signalling on the Underground Railways of London. Illustrated description of the system installed on the District Railway. The main feature is that currents extraneous to the signal system cannot affect the apparatus so as to cause a false indication of safety. 7500 w. Engng—May 25, 1906. Serial. 1st part. No. 77138 A.

Subway.

The Chicago Freight Subway. Editorial on this interesting engineering work, the useful function it is designed to serve, its capacity, operation, and effect on present conditions of freight service. 1200 w. R R Gaz—June 1, 1906. No. 77052.

Subway Temperature.

An Official Report on Heat Conditions in the New York Subway by Chief Engineer George S. Rice. A full statement of the conditions and possible remedies. 6500 w. Eng News—June 7, 1906. No. 77241.

Tests.

Experimental Work of the Electric Railway Test Commission. Henry H. Norris. A résumé of the results of the work of the Test Commission, and a discussion of the relation of the experiments to the general field of electric railway practice. 2200 w. Sib Jour of Engng—June, 1906. No. 77325 C.

Traffic.

Influences Determining Street Railway Traffic in German Cities. Wilhelm Mattersdorf. Considers the relations between the traffic and the population of a city; between the traffic and its determining operating factors; between operation and population; and the relation of car-kilometers run to passengers carried. 2800 w. St Ry Jour—June 2, 1906. No. 77057 C.

Wheels.

Rolled Steel Wheels for Interurban Service. H. S. Newton. Discusses facts in regard to these wheels as developed in the service of the Hartford & Springfield road; the amount and character of the wear, the carbon component, shop methods, for the re-shaping, and a comparison of the rolled-steel with the chilled-iron wheel. 4500 w. St Ry Jour—June 16, 1906. No. 77307 C.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves readv to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.